SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE fifty-second annual meeting of the association, which was held in Washington, D. C., from December 29 to January 3, was noteworthy in many respects as marking the passage to a new order of things in the position and conduct of the association. The total enrollment reached 989, which is second to that of the Boston meeting in 1880, when 997 were enrolled, and to that of the second Philadelphia meeting in 1884, when 1,261 enrollments appear. Of these, however, 303 members of the British Association represent complimentary enrollments. The geographic distribution of the members in attendance was as follows:

District of Columbia, 354; New York, 133; Massachusetts, 82; Pennsylvania, 70; Ohio, 39; Maryland, 38; Illinois, 27; Connecticut, 23; Michigan, 22; New Jersey, 19; Wisconsin, 19; Indiana, 16; Virginia, 14; North Carolina, 13; California, 12;

New Hampshire, 10; Missouri, 8; Canada, 8; Nebraska, 7; Minnesota, 7; Vermont, 6; Rhode Island, 4; Tennessee, 4; Kentucky, 4; Iowa, 4; Florida, 3; Maine, 2; West Virginia, 2; South Carolina, 2; Georgia, 2; Texas, 2; Montana, 2; Colorado, 2; Delaware, 1; Wyoming, 1; Arkansas, 1; Mississippi, 1; Kansas, 1; South Dakota, 1; Alabama, 1; New Mexico, 1.

Foreign attendance: Canada, 8; England, 1; Ceylon, 1; Nicaragua, 1.

In addition to these, 363 members of affiliated societies also registered at the office of the association, so that the total enrollment of scientific men in attendance at the meetings was 1,352, and the total attendance may be conservatively estimated as not less than 1,500.

The membership of the association, which had reached at the Pittsburgh meeting a total of 3,473, was augmented by the election at this meeting of 392 additional persons. One may assert with reasonable confidence that the gathering was the most representative and extensive which has ever been held under the auspices of any purely scientific association in this country and stands in favorable comparison with any similar congress in other lands. This was undoubtedly due in part to the advantages of Washington in accessibility and attractiveness, as well as to the large number of affiliated societies which cooperated in the gathering. One may well affirm that the experiment of changing the time of meeting has proved a distinct success, and this is evident not only in the size of the gathering but in the characteristic features of the series of meetings as well.

In the first place, it was noteworthy that the attendance was composed in great majority of the working scientific men of the country. The meetings of the various sections were well attended and the spirit of the sections was one of work, most gratifying to those who look for renewed scientific interest and activity as a result of the change in policy of the association. It is further noteworthy that the number of affiliated societies has been increased by the addition of many of the permanent scientific organizations of the country. Such an assemblage could not be made without numerous and even serious conflicts, together with the inconvenience and even friction which is attendant upon such relations. While this was noticeable in a few points which may possibly result in the temporary withdrawal of a few organizations, the advance made has been no less permanent than real in character.

To be sure, there are some scientific men who have not yet grasped the meaning of organization in scientific fields, and to whom the temporary inconveniences of an affiliation, the minor details of which have not yet been completed, appear to overshadow the great benefits which must result to science at large from the strength of the ultimate union. Despite this, the broader view has appealed so strongly to the members of most sections that amicable relations have been entered into between these and the national societies of technical character, and there has resulted a great improvement of the program for those in attendance upon the meetings and of effort and influence for the mutual advancement of the organizations. No one can doubt this on examination of the programs of the sections, which manifest an especially high standard in the character of the papers presented. Those in attendance upon future meetings may look with confidence to the presentation only of that which is most valuable to the worker in the field of the section. The marked improvement in the character of the contributions can only be demonstrated by the reports of the secretaries, which will appear subsequently. The more serious

character of the meeting was directly reflected in the marked respect paid to it by the press, and the period during which the influence of the association will be commensurate with the importance of the subjects it represents may be confidently said to have commenced.

Despite occasional criticisms of individuals as to the excessive growth of machinery, the association still needs perfecting in some details of organization in order to handle with expedition and without friction the enormous mass of business incident to the association of such wide scientific interests. Many details might profitably be systematized and removed from the hands of the overburdened secretaries, to be discharged in routine fashion by errand boys or clerks, and once provided for, would be carried out through successive years as a matter of course and without demand upon the time of any officer of the association, whose energy may better be devoted to the performance of the scientific duties connected with his post. Every means possible should be employed to enable officers, as well as members, to lend their energies to those objects for which the association primarily exists, and with the perfection of this machinery will cease of necessity the isolated criticisms which have been made by those of pessimistic habit with regard to the over-organization of the association. The same machinery which was adequate to provide for the needs of an organization of 1,000 members with an annual attendance of 200 will not suffice for an association of four times that size and attendance. The sooner scientific men profit from the experience and practice of successful enterprises in the world of business, the greater will be the success of the forward movement in the world of science.

One cannot overestimate the part which is being played in this new movement by the affiliated societies, many of international renown, which have come into relations with the association. Most of these are of technical character and are establishing with the sections desirable relations of an advisory and directive type. This they are well able to do by virtue of the professional character of their membership, and American science may confidently expect great results from the intimate relation in which such societies stand to many of the sections. It is to be sincerely regretted that in one or two cases the spirit of the movement has failed to reach other organizations, where some members have strongly opposed the cultivation of any relations whatever, and it may be given as more than an individual opinion that such men have failed to give thoughtful consideration to the real consequences of the armed neutrality which their position invokes. It may be said with frankness that even before such organizations some matters of the most trivial character are presented, while the section programs have to offer that which would be of broad and genuine interest to the members of the society. Both sides have much to gain, and neither has anything comparable or even considerable to lose by the proposed *entente cordiale.*

It would be improper to pass the subject of these affiliated societies without reverting in a word to one of an entirely different character which has played an important part at Washington. The American Society of Naturalists has performed an invaluable service for those in attendance in its afternoon discussion on the most effective use of endowments for scientific research, which was participated in by six members of broad view and striking individuality, and by its annual dinner, with an address by the president on the characteristics and distribution in different fields of American men of science,

which provoked generous and general discussion of the questions involved.

Important progress was made toward the establishment of a permanent policy in the association by several amendments to the constitution and practices which were put into operation. The members of the sectional committees were elected for terms varying in length from one to five years, thus insuring the continuance of at least four members familiar with committee work from one year to the next; the secretaries of the sections were elected for terms of five years, and the council elected nine fellows at large for varying terms. The continuity this secures in the governing body of the association will add greatly to its efficiency in the advancement of science. The members at large, with their terms of service, are as follows:

J. McK. Cattell, U. S. Grant, William Kent, term ending 1904.

J. M. Coulter, A. A. Noyes, H. F. Osborn, term ending 1905.

Franz Boas, E. L. Nichols, W. F. Wilcox, term ending 1906.

The following resolutions of importance to the policy of the association were discussed and adopted:

Resolved, That any section is hereby authorized to arrange through its sectional committee for an independent summer meeting in any year when the association fails to hold a summer meeting; provided, that the time and place of meeting and the general program be approved by the president and permanent secretary of the association and that a full report of its meeting be sent to the permanent secretary. The expenses of any such meeting to an amount not exceeding fifty dollars will be borne by the association.

Resolved, That Section E is hereby authorized to suspend its scientific program of the reading of papers at any winter meeting when the Geological Society of America meets in conjunction with the association; provided that the Geological Society includes in its program the papers of worthy character offered by members of the section who are not fellows of the society.

Resolved, That each section is recommended to hold during each general meeting at least one afternoon session when a program of general interest shall be presented.

It was recommended that the elections to fellowship be announced to the section from which the member elected had been recommended.

The council voted unanimously to increase the salary of the permanent secretary from $1,250 to $1,500 on account of the greatly increased membership of the association and attendance at the meetings, which have multiplied the duties devolving upon the office.

The amendment to the constitution proposed at the Pittsburgh meeting and printed in full in Science, Volume XVI., page 42, was adopted, and further amendments were presented altering the word 'assessment' to 'dues' in three places.

Resolutions, demonstrating the important part that will hereafter be taken in the association by the newly established section of physiology and experimental medicine, were passed as follows:

Resolved, That the American Association for the Advancement of Science hereby records its sense of the great loss sustained by science in the death of Major Walter Reed, surgeon in the United States Army, and its appreciation of the far-reaching and invaluable services which he has rendered to humanity. By solving the problem of the mode of spread of yellow fever, Major Reed not only made a great contribution to science, but at the same time conferred inestimable benefits upon his country and upon mankind. To have discovered and demonstrated the methods, which have already been successfully tested in Cuba, of eradicating a wide-spread and terrible pestilence, is a benefaction of imperishable renown, of incalculable value in the saving of human lives, of vast importance to commercial interests, and deserving of the highest rewards in the power of his countrymen to bestow. This association earnestly urges upon the attention of Congress the duty of making full provision for the support of his family.

Resolved, That the President designate a committee of nine members of this Association, with power to increase its number, which shall be authorized and requested to devise and carry out a

plan, or aid in similar efforts elsewhere instituted, by which a suitable and permanent memorial of this great benefactor of his race may be secured. This committee shall be authorized to prepare and publish a statement of the services of the late Major Reed in discovering the mode by which yellow fever may be exterminated.

The members appointed by President Remsen to serve as such committee are: Dr. D. C. Gilman, Dr. A. Graham Bell, General George M. Sternberg, Mayor Seth Low, Hon. Abram S. Hewitt, President J. G. Schurman, Dr. S. E. Chaillé, Dr. W. H. Welch, Dr. Charles S. Minot.

The second resolution was as follows:

Inasmuch as the construction of the isthmian canal is through a region in which without energetic sanitary control there is sure to be enormous loss of human life from preventable diseases, particularly from pernicious malaria and yellow fever, as well as great waste of energy and of money from disabilities caused by such diseases, and

Inasmuch as the measures for the restraint of these diseases, which have already achieved even their extermination in Cuba under American administration, require expert knowledge based upon practical familiarity with tropical diseases, experience in the application of these measures, and large authority in their administration,

RESOLVED, That the American Association for the Advancement of Science begs most respectfully and earnestly to call to the attention of the President of the United States the importance of appointing as a member of the Isthmian Canal Commission a medical man possessed of the qualifications indicated. The association is convinced that the mere employment of such a sanitary expert by the commission will not be likely to secure the desired results.

RESOLVED, That the permanent secretary of the association transmit a copy of these resolution to the President of the United States.

Section F recommended to the council the following resolution, which was adopted:

The American Association for the Advancement of Science heartily endorses the plan of converting the Donnelson estate, which has recently become the property of the State of Indiana, into a State Reserve, and urges upon the legislature of Indiana the advisability of setting aside a part of it for an experimental farm for the investigation of cave animals and plants by American naturalists.

The grants recommended by the council and announced to the general session were as follows:

To the committee on the atomic weight of thorium, $50.

To the committee on anthropometry, $50.

To the Concilium Bibliographicum, $100.

In addition to these it was announced that the Botanical Society of America had made the following grants in aid of research:

To Dr. J. C. Arthur, $90, to be used in the prosecution of his investigations of the plant rusts.

To Dr. Arthur Hollick, $150, to be used in the prosecution of a study of the fossil flora of the Atlantic coastal plain.

To Dr. D. S. Johnson, $200, to enable him to obtain material from tropical America and carry forward his studies of the endosperm and seed in the Piperaceae and Chloranthaceae.

The reports of the committees on the teaching of anthropology, on indexing chemical literature and on the atomic weight of thorium were duly received and will be printed subsequently. Other reports were submitted and adopted, as follows:

COMMITTEE ON ANTHROPOMETRY.

This committee begs to report that anthropometric researches have been continued at Columbia University under the direction of its New York members and with the cooperation of Professor Farrand, Professor Thorndike, Dr. Wissler, Mr. Bair, Mr. Davis and Mr. Miner. Tests have been made on the freshmen entering the college, calculations have been carried out on measurements of school children, and new determinations of the mental traits of school children have been made and correlated. The chairman of the committee has carried forward an extensive anthropometric study of American men of science, the preliminary results of which formed the subject of his address as president of the American Society of Naturalists. An anthropometric laboratory has been arranged at the present meeting of the association, with the $50 appropriated at the Pittsburgh meeting for the purpose, and tests of the physical and mental traits of members are being made. We ask that this committee be continued and that a

further appropriation of $50 be made in order that a similar laboratory may be arranged at the next meeting of the association.

J. McK. CATTELL,
W J McGEE,
FRANZ BOAS.

WASHINGTON, D. C., December 30, 1902.

Council, American Association for the Advancement of Science. Gentlemen: In behalf of the committee on cave investigation, I beg leave to submit the following report of work in hand and contemplated.

The most important single item of interest is the discovery that there are two instead of one species of *Typhlichthys* south of the Ohio River. I secured the second species at Horse Cave, Kentucky, in numbers and under conditions that practically insure the securing of a complete series of individuals illustrating the life history from the egg to old age.

A colony of *Amblyopsis* has been successfully transplanted to a cave within five miles of my laboratory, where they are breeding.

A preliminary examination of the eyes of the Cuban blind fish shows that the amount of ontogenetic degeneration is very great, and that the variability of this useless organ is all and much more than the cessation of natural selection would lead one to expect.

With an assistant I have undertaken a series of measurements of the physical conditions of Mammoth Cave, chiefly of the air currents at the entrance and in different galleries of the cave, and the temperature in a series of places.

The colony of *Amblyopsis* planted in an outdoor pool has come to grief. It demonstrated beyond a doubt that the cave vertebrates can be colonized in open pools, and this should be done at once.

There is a balance of about $45 on hand out of the $75 appropriated at the last meeting.

Respectfully submitted,
C. H. EIGENMANN.

COMMITTEE ON VARIATION.

The most important events relating to the study of variation that have occurred during the past two years have been the establishment of the journal *Biometrika*, the foundation in America of a Society of Plant and Animal Breeding, the completion of the first volume of De Vries' 'Mutationsteorie,' and the rediscovery of Mendel's Law of Hybridity. Especially the latter two events have awakened a strong tendency toward the experimental study of evolution.

During the last four months the recorder has visited many of the experimental evolutionists of Europe. While the total work on this subject in Europe is of the greatest importance, it is carried on under conditions that greatly hamper the work and make it impossible to start experiments that require to be carried on for a long period of years. Everywhere the hope was expressed that in America a permanent station for experimental evolution would be founded, and it was believed that the Carnegie Institution would be the proper organization to initiate and maintain such a station.

CHAS. B. DAVENPORT,
Recorder.

Owing to the fact that the meeting began before the close of the fiscal year, the financial reports from the permanent secretary and the treasurer were presented informally, and the formal reports were postponed until the April meeting of the council.

In the sessions of the council and of the association the usual order of procedure was followed. Events of more general interest in these as well as during the days of the meeting may be chronicled as follows:

The first general session of the association was held on Monday, December 29, 1902, at 10 A.M., in St. Matthews Church. It was called to order by the retiring President, Professor Asaph Hall, U.S.N., who introduced the President-elect, Dr. Ira Remsen. Cordial addresses of welcome were delivered by Dr. Charles D. Walcott, in behalf of the Washington Academy of Sciences and other scientific societies; the Hon. Henry B. F. Macfarland, on behalf of the District of Columbia; Hon. David J. Hill, on behalf of the National Government; and Dr. Charles W. Needham, President of Columbian University, on behalf of the educational institutions of Washington. To these President Remsen responded.

At one o'clock P.M. on Monday the local committee invited visiting scientific people to a luncheon at the Arlington, and on the same afternoon the address of the vice-

presidents, now in course of publication in SCIENCE, were given as follows:

At 2:30 P.M.:

Vice-President Hough before the Section of Mathematics and Astronomy on the third floor of the Columbian University, main building.

Vice-President Franklin before the Section of Physics on the second floor of the Columbian University Law School (Lecture Hall A). Subject: 'Limitations of Quantitative Physics.'

Vice-President Weber before the Section of Chemistry on the second floor of the Columbian University Medical School. Subject: 'Incomplete Observations.'

Vice-President Culin before the Section of Anthropology on the first floor of the Columbian University Law School. Subject: 'New World Contributions to Old World Culture.'

Vice-President Welch before the Section of Physiology and Experimental Medicine in the main lecture room, first floor, main building of the Columbian University.

At 4 P.M.:

Vice-President Flather before the Section of Mechanical Science and Engineering on the second floor of the Columbian University Law School (Lecture Hall B). Subject: 'Modern Tendencies in the Utilization of Power.'

Vice-President Nutting before the Section of Zoology on the second floor of the Columbian University Medical School. Subject: 'Some of the Perplexities of a Systematist.'

Vice-President Campbell before the Section of Botany on the first floor of the Columbian University Medical School. Subject: 'The Origin of Terrestrial Plants.'

Vice-President Wright before the Section of Social and Economic Science in the main lecture room, first floor, main building of Columbian University. Subject: 'The Psychology of the Labor Question.'

At this hour also was delivered the address of the president of the Astronomical and Astrophysical Society of America, Professor Simon Newcomb.

The annual address of the retiring president, Professor Asaph Hall, U.S.N., read on Monday evening, was published in the last issue of SCIENCE. At its close Past-President C. S. Minot spoke of the new movement on which the association has entered.

On Tuesday evening the address of the president of the American Chemical Society, Dr. Ira Remsen, was given and followed by the annual dinner of the society.

At the same time Dr. C. Hart Merriam delivered the public lecture of the American Society of Naturalists on 'Protective and Directive Coloration of Animals with Especial Reference to Birds and Mammals,' which was followed by the smoker of the American Society of Naturalists and its affiliated societies. At the same time the Botanical Society of Washington received visiting botanists. The Sigma Xi Scientific Society also met the same evening.

On Wednesday afternoon at 3 o'clock the annual discussion of the American Society of Naturalists was held. The subject was 'How can Endowments be used most Effectively for Scientific Research?' and the speakers were Professors T. C. Chamberlin, William H. Welch, Franz Boas, William M. Wheeler, Conway Macmillan and Hugo Münsterberg.

On Wednesday afternoon at 4 o'clock a public lecture was given under the auspices of the A. A. A. S. and the National Geographic Society on 'Volcanoes of the West Indies,' by Professor I. C. Russell.

Mrs. Chas. D. Walcott gave a tea on Wednesday afternoon at 5 o'clock to visiting ladies of the association, and to the members of the Geological Society of America.

On Wednesday evening the annual dinner of the American Society of Naturalists was held, and the dinner was followed by the address of the president, Professor J. McK. Cattell.

The annual dinner of the Geological Society of America and a smoker tendered by the Chemical Society of Washington were also held.

On Thursday evening, through the courtesy of the board of regents and the secretary of the Smithsonian Institution, the U. S. National Museum was open from

8:30 to 11 P.M., to afford a convenient opportunity for viewing the collections.

On Friday afternoon at 4 o'clock an illustrated public lecture complimentary to the citizens of Washington was given at the Lafayette Opera House, by Professor John Hays Hammond, on 'King Solomon's Mines, or the Mines of Ophir.'

On Friday evening the trustees of the Corcoran Art Gallery and the local committee tendered a reception to the visiting members of the association and the affiliated societies at the Corcoran Art Gallery, from 8:30 to 11 o'clock. On Friday evening also was held the dinner of the American Alpine Club.

On Saturday morning at 10 o'clock the President of the United States received the members of the A. A. A. S. and affiliated societies at the White House.

Resolutions of thanks for courtesies extended were offered by Ex-President Minot and unanimously adopted at the closing general session. The institutions and individuals to whom the association was especially indebted include: Columbian University, Cosmos Club, Local Committee and its secretary (Dr. Benjamin), St. Matthew's Church, Georgetown University, Caroll Institute, Press of Washington, Trustees of Corcoran Art Gallery, the President of the United States, secretary of the Smithsonian Institution, acting director of the U. S. National Museum, director of the Naval Observatory, U. S. commissioner of Fish and Fisheries.

At the meeting of the general committee on Thursday evening it was decided to hold the next meeting of the association in St. Louis during convocation week, 1903–4, and to recommend Philadelphia as the place of the following meeting. The following were elected officers for the St. Louis meeting:

President—Carroll D. Wright, Washington.

Vice-Presidents—Section A, Mathematics and Astronomy, O. H. Tittmann, Washington; B, Physics, E. H. Hall, Harvard University; C, Chemistry, W. D. Bancroft, Cornell University; D, Mechanical Science and Engineering, C. M. Woodward, Washington University; E, Geology and Geography, I. C. Russell, University of Michigan; F, Zoology, E. L. Mark, Harvard University; G, Botany, T. H. Macbride, University of Iowa; H, Anthropology, M. H. Saville, American Museum of Natural History; I, Social and Economic Science, S. E. Baldwin, New Haven; K, Physiology and Experimental Medicine, H. P. Bowditch, Harvard University.

Permanent Secretary—L. O. Howard, Cosmos Club, Washington.

General Secretary—Chas. W. Stiles.

Secretary of the Council—Chas. S. Howe, Case School.

Secretaries of the Sections.—Section A, Mathematics and Astronomy, L. G. Weld, University of Iowa; B, Physics, D. C. Miller, Case School; C, Chemistry, A. H. Gill, Massachusetts Institute of Technology; D, Mechanical Science and Engineering (none proposed); E, Geology, G. B. Shattuck, Baltimore; F, Zoology, C. Judson Herrick, Denison University; G, Botany, F. E. Lloyd, Teachers College, Columbia University; H, Anthropology, R. B. Dixon, Harvard University; I, Social and Economic Science, J. F. Crowell, Washington; K, Physiology and Experimental Medicine, F. S. Lee, Columbia University.

Treasurer.—R. S. Woodward, Columbia University, New York, N. Y.

HENRY B. WARD,
General Secretary.
THE UNIVERSITY OF NEBRASKA.

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*MODERN TENDENCIES IN THE UTILIZATION OF POWER.**

IT has been stated that to the construction and perfection of her machinery, more than to any other cause, may be ascribed the present commercial supremacy of the United States.

Be that as it may, the economical production of her manufactures and the convenient adaptations of time and labor

* Address of the chairman of Section D, Engineering and Mechanical Science, and vice-president of the American Association for the Advancement of Science. Read at the Washington meeting, December 29, 1902.

saving devices in all the various lines of constructional work have certainly exerted a wonderful influence in the upbuilding of her industries.

Specialization in the manufacture of machine tools and labor-saving devices has followed closely the segregation of processes in other lines of industry, and thus there has been created a multitude of special machines, each designed to perform some single and often very simple operation.

Among other significant features the present tendency in the development and use of this class of machinery is marked by the adaptation of compressed air and the application of electric power to machine driving. In the use of compressed air, the facility of adaptation to various requirements which are in many cases additional to the supply of motive power, is a valuable feature peculiar to this system and one which is susceptible of extension along many lines.

The labor cost in most machine shops and other works is so much greater than the cost of power, that any expedient by which the labor cost may be appreciably reduced is justified, even though the efficiency of the agent itself be low. Whenever new methods or agencies cause an increased production with a given outlay for labor, we shall find these methods superseding the old, even though the cost of the power required be greater than before. The saving of power is a consideration secondary to the advantages and economical output obtained by its use.

While economy in the use of power should therefore be secondary to increased output, yet careful attention to details will often greatly reduce the useless waste of power.

Engineers have recognized for some time past that there is a very great percentage of loss due to shaft friction, which, in railroad and other shops where the buildings are more or less scattered, may be as great as 75 per cent. of the total power used. In two cases known to the speaker these losses are 80 and 93 per cent., respectively. In the ordinary machine shop this loss will probably average from 40 to 50 per cent. No matter how well a long line of shafting may have been erected, it soon loses its alignment and the power necessary to rotate it is increased.

In machine shops with a line of main shafting running down the center of a room, connected by short belts with innumerable counter-shafts on either side, often by more than one belt and, as frequently happens, also connected to one or more auxiliary shafts which drive other countershafts, we can see why the power required to drive this shafting should be so large. There is no doubt, however, that a large percentage of the power now spent in overcoming the friction of shafting in ordinary practice could be made available for useful work if much of the present cumbrous lines of shafting were removed.

Manufacturers are realizing the loss of power which ensues from the present system of transmission, and we find a general tendency to introduce different methods by which a part of this loss will be obviated. Among these are the introduction of hollow and lighter shafting, higher speeds and lighter pulleys, roller bearings in shaft hangers, and the total or partial elimination of the shafting.

Independent motors are often employed to drive sections of shafting and isolated machines, and among these we find steam- and gas-engines, electric motors, compressed air and hydraulic motors, although the latter have not been used for this purpose to any appreciable extent.

In the choice of motors, until quite recently the steam-engine has heretofore been

used, especially where the units are relatively large. An interesting example of this is noted in the sugar refinery of Claus Spreckles, in Philadelphia, in which there are some 90 Westinghouse engines about the works, many of them being of 75 and 100 horse-power each, others are of 5 and 10 horse-power only. A similar subdivided power plant involving 42 engines was erected several years ago at the print works of the Dunnell Co., Pawtucket, R. I.

It was only a comparatively few years ago when several large and economical Corliss engines were replaced at the Baldwin Locomotive Works by a greater number of small, simple expansion engines, which actually required about 15 per cent. more steam per horse-power-hour than the Corliss engines. This loss, however, was only apparent, for by increasing the number of units and locating them at convenient centers of distribution much of the shafting and belting could be dispensed with and an actual saving was obtained. Later, these simple engines were replaced by a number of compounds, some eighteen being in service; subsequent tests on these showed a saving of 36 per cent. over that obtained by the use of the simple engines.

More recently, however, the electric motor has superseded the steam-engine for this work, as its economy and convenience over the latter are now thoroughly recognized.

The statistics of American manufacturing compiled by Mr. T. C. Martin for the United States Census Office, show that at the time of the last census, in 1900, electric power was less than five per cent. of all that was in use in such plants, or about 500,000 horse-power out of a total of 11,000,000; but, as Mr. Martin states, things are to be judged by tendencies rather than by the *status quo*, and these electric motor figures exhibit an increase of 1,900 per cent. during the decade.

The introduction of the electric motor in machine shops and factories was at first looked upon with disfavor and was opposed by many manufacturers, but the innovation obtained a foothold, and advantages which were at first unforeseen were found to attend its use, so that now it is being very generally adopted for a wide variety of work.

A considerable difference of opinion exists as to whether individual motors should be used with each machine, or whether a number of machines should be arranged in a group and driven from a short line shaft.

There are well-defined conditions to which each system is best adapted, but there are wide limits between which there appears to be no general rule, and we find both methods occupying the same field.

For isolated machines and for heavy machines that may be in occasional use the individual motor is particularly well adapted, as it consumes power only when in operation. It is, however, necessary that each motor thus connected shall be capable of supplying sufficient power to operate its machine under the heaviest as well as lightest loads. In certain cases, moreover, the load is liable to very great irregularity, as for instance in metal-working planers, in which the resistance offered by the machine at the moment of reversal of the platen is far higher than at other times, and may be so great as to endanger the armature of the motor. Under these conditions it is necessary to use a motor of much larger capacity than the average load would indicate.

Fortunately with electric motors the rated capacity is usually less than the safe maximum load, which is determined either by the heating of the conductors, tending to break down the insulation, or by ex-

cessive sparking at the brushes. For momentary overloads relatively large currents may pass through the coils without injury to the insulation, since the temperature effect is cumulative and requires time for its operation. However for continuous periods of considerable length it is usually unsafe to operate the motor much above its rated output.

Ordinarily in machine-driving the motor is shunt-wound, and the current through the field-coils is constant under all conditions of load; but to obtain the best results with that class of machinery in which the load is intermittent and subject to sudden variations, the motor should be compound-wound so as to increase the torque without an excessive increase of current in the armature.

In many cases with individual motors, owing to wide variations in power required, the average efficiency of the motor may be very low; for this reason a careful consideration of the conditions governing each case indicates that for ordinary machine-driving, especially with small machines, short lengths of light shafting may be frequently employed to good advantage, and the various machines, arranged in groups, may be driven from one motor. By this method fewer motors are required, and each may be so proportioned to the average load that it may run most of the time at its maximum efficiency.

When short lengths of shafting are employed the alignment of any section is very little affected by local settling of beams or columns, and since a relatively small amount of power is transmitted by each section, the shaft may be reduced in size, thus decreasing the friction loss. Moreover, with this arrangement, as also with the independent motor, the machinery may often be placed to better advantage in order to suit a given process of manufacture; shafts may be placed at any angle without the usual complicated and often unsatisfactory devices, and a setting-up room may be provided in any suitable location as required, without carrying long lines of shafting through space. This is an important consideration, for not only is the running expense reduced thereby, but the clear head-room thus obtained, free from shafting, belts, ropes, pulleys and other transmitting devices, can be more easily utilized for hoists and cranes, which have so largely come to be recognized as essential to economical manufacture.

In arranging such a system of power distribution the average power required to drive is of as much importance as the maximum, for in a properly arranged group system the motor capacity need not be the equivalent of the total maximum power required to operate the several machines in the group, but may be taken at some value less than the total, depending upon the number of the machines and the average period of operation. On the other hand as already shown, the motor capacity of independently driven machines must not only equal the maximum power required to drive the machine at full load, but it must be capable of exerting a greatly increased momentary torque. In any case large units should be avoided, for the multiplication of machines driven from one motor entails additional shafting, countershafts and belting which may readily cause the transmission losses to be greater than those obtained with engines and shafting alone, besides frustrating some of the principal objects of this method of transmission.

As far as the efficiency of transmission is concerned, it is doubtful whether, in a large number of cases, motor-driving *per se* is any more efficient than well-arranged engines and shafting.

As already pointed out, the principal

thing to be kept in mind is a desired increase in efficiency of the shop plant in turning out product, with a reduction in the time and labor items, without especial reference to the fuel items involved in the power production.

On account of the subdivision of power which results from the use of many motors, there is less liability of interruption to manufacture, and in case of overtime it is not necessary to operate the whole works, with its usual heavy load of transmitting machinery.

Another advantage is the adaptability to changes and extensions; new motors may always be added without affecting any already in operation, and the ease with which this system lends itself to varying the speed of different unit groups is a very potent factor in its favor.

One serious obstacle to the use of connected motors with machine tools is the difficulty of obtaining speed variation, which is so necessary with a large proportion of the machines in common use. A certain amount of variation can be obtained by rheostatic control—a wasteful method; or by using a single voltage system with shunt field regulation; but the variation in either case is very limited. This, however, may be increased by using a double commutator if space will permit.

The three-wire, 220-volt system offers many advantages for both power and lighting systems, and is very frequently employed. Variations of speed may be obtained with this system by using a combination of field regulation with either voltage, and, in rarer cases, the use of a double commutator motor.

A method which has been used recently with considerable satisfaction involves the use of a three-wire generator, with collector rings connected to armature winding similar to that of a two-phase rotary converter. Balancing coils are used, and the middle points of these are connected to the third wire, which is thus maintained at a voltage half-way between the outer wires. This system is simple and economical, and possesses all the advantages of the ordinary three-wire method; it permits similar variations in speed by field regulation with either voltage; and if still wider ranges are desired a double commutator motor may also be used.

In other recent installations the four-wire multiple voltage system is used, which permits of very wide variations of speed in the operation of the tool. This system gives excellent results and removes one of the objections urged against direct-connected motor-driven tools, namely, that such machines are not sufficiently flexible in regard to speed variation, and that such variation can only be obtained by throwing in resistances which cut down the efficiency of the motor, or by varying the strength of field which reduces the torque.

The multiple voltage system, however, has some serious disadvantages. It can not usually be operated from an outside source of power without rotary transformers; the generating sets and switch-board are complicated and the total cost of installation is expensive; yet with these drawbacks the system is growing in favor, as it has manifest advantages which outweigh the objections.

The storage battery has been used to some extent to obtain multiple control and is suggestive of interesting possibilities, but in its present form it is not altogether desirable for machine tools.

In many of the larger sizes of certain metal-cutting machines it is probable that marked changes will be produced in the immediate future, and the indications are that direct-connected motors with wide variations of speed and power will be incorporated in the new designs.

The recent improvements in the manufacture of certain grades of tool steel have shown indisputably that the present designs of machine tools are not sufficiently heavy to stand up to the work in order to obtain the economy of operation which results from the use of such steels. Higher speeds, heavier cuts and greater feeds may be obtained if the machines will stand the strain, but in most cases the capacity of the machine is not commensurate with the ability of the tool to remove metal. With cutting speeds of 100 to 200 feet per minute, it is evident that the power requirements will be much greater than for the ordinary machines of to-day, which have a cutting speed of from 10 to 30 feet per minute. As an illustration of what can be done with these new tool steels the speaker was recently shown some steel locomotive driving-wheels which had been turned up in two hours and forty minutes, whereas the regular time formerly required was not less than eight hours. In this case even better results could have been obtained, but the belts would not carry the load.

Here then we find an interesting field for the direct-connected motor with ample power and speed variation for any work which it may be called upon to perform.

While the preference is easily given to continuous-current motors for the purposes of machine driving, yet we find alternating current motors used to a considerable extent, the proportion of motors in service being about one to five in favor of the continuous-current motor. Both synchronous and induction motors are employed, but the advantages possessed by the latter cause this type to be preferred, although in long-distance transmissions, both types should be used in order to obtain satisfactory regulation. As shown by Mr. H. S. Meyer,* the induction motor can readily be worked at variable speeds, which is accomplished in three different ways: (1) by rheostatic control, which is decidedly the cheapest and easiest method to manipulate; (2) by varying the impressed voltage, which, however, necessitates the use of a transformer or compensator with variable ratio; this is very inefficient at the lower speeds and can only be used under certain conditions; and (3) by altering the number of poles, which is mechanically very complicated, but where the speed variation is only one half or one quarter it may be used efficiently.

* *London Engineering*, April 19, 1901.

One serious disadvantage met with in all induction motors is the lag produced by self-induction, and its reaction on the circuit. This lag is particularly unsatisfactory with intermittent service, such as machine driving, where the motors have to run under light and variable loads; in such cases the power factor is probably not over 60 or 70 per cent.

Reference has been made to the use of compressed air and its facility of adaptation to various requirements, but it is evident from an inspection of some of the devices in use that enthusiasm for new methods, rather than good judgment, has controlled in many of its applications.

For some years compressed air was used only in mines, where it produced marked economies in underground work. Later, compressed air was introduced into manufacturing lines, and to-day its use in railroad and other machine shops, boiler shops, foundries and bridge works is being widely extended. In the Santa Fe Railroad shops at Topeka there are over five miles of pipe in which compressed air is carried to the different machines and labor-saving appliances throughout the works.

In such shops air is used to operate riveting machines, punches, stay-bolt breakers, stay-bolt cutters, rotary tapping and drilling machines, flue rollers, rotary grinders,

rotary saw for sawing car roofs, pneumatic hammers, chisels and caulking tools, flue welders, boring and valve-facing machines, rail saws, machine for revolving driving-wheels for setting valves, pneumatic painting and whitewashing machines, dusters for car seats and the operation of switching engines about the yard. It is also used in the foundry for pressing and ramming molds, and for cleaning castings by the sand blast; but its greatest field of usefulness is its application to hoisting and lifting operations in and about the works.

New applications of compressed air are constantly being made, and each new use suggests another. This has a tendency to increase the number of appliances which are intended to be labor-saving devices, but in many cases the work could be done just as well and much more cheaply by hand.

A case in point is seen in an apparatus which was at one time in use on one of our prominent western roads. It was a sort of portable crane hoist which could be fastened to the smoke-stack of a locomotive, whereby one man could lift off the steam chest casing. The hoisting apparatus weighed about twice as much as the steam chest and took three men to put it up. When piece work was adopted two men easily lifted off the steam chest and this 'time and labor saving device' was relegated to the scrap heap.

While compressed air has been used to some extent for inducing draft in forge fires, it is unquestionably a very expensive method. Tests to determine this show that it costs twenty-five times as much to produce blast in that way as it would with a fan.*

The success and economy which has attended the use of compressed air in so many lines of work has led to its adoption in fields which are much better covered by electrically operated machines. While compressed air has been used under certain conditions very satisfactorily to operate pumps and engines, printing-presses, individual motors for lathes, planers, slotters, dynamos and other work, it does not follow that it is always an economical agent under these various uses, or that other methods could not be used even more satisfactorily in the majority of cases.

It has been proposed to use individual air motors in machine shops and do away with all line shafting, except possibly for some of the heavier machinery. This use of compressed air seems entirely outside the pale of its legitimate field; the general experience thus far indicates that rotary motors are not at all economical and generally are not as satisfactory as electric motors.

Exceptions are to be found in the small portable motors for drilling and similar operations, to which electricity is not at all adapted and where compressed air has been found to give excellent results. The saving obtained by the use of such portable drills as compared with a ratchet drill is very marked.

Although these tools are very successful they are still rotary motors, not exempt from some of the objectionable features which seem to be inseparable from them. It is not surprising, therefore, to find a tendency to employ reciprocating pistons and cranks in these portable machines and we note such tools weighing only forty pounds capable of drilling up to two and a half inches diameter.

While the field is to some extent limited, yet the uses of compressed air are certainly not few, and in many lines of work marked economy results from its use.

In most cases no attempt has been made to use the air efficiently; its great convenience and the economy produced by its displacement of hand labor have, until re-

* *Proc. Western Ry. Club*, 1898.

cently, been accepted as sufficient, and greater economies have not been sought.

In the matter of compression we still occasionally find very inefficient pumps in use, but manufacturers generally have found that it pays to use high-grade economical compressors. The greatest loss is that in the air motor itself. In a large number of cases it is impracticable or, at most, inconvenient to employ reheaters, and we find very generally that the air is used at normal temperature for the various purposes to which it is applied.

To obtain the most satisfactory results the air must be used expansively, but usually where the demand for power is intermittent no attempt has been made to reheat the air, and as a result the combined efficiency of compressor and motor is quite low, varying in general from 20 to 50 per cent. While low working pressures are more efficient than high, the use of such pressures would demand larger and heavier motors and other apparatus which is undesirable.

The advantages of higher pressures in reducing cost of transmission are also well recognized, and the present tendency is to use air at 100 to 150 pounds instead of the 60 or 70 pounds of a few years ago.

By reheating the air to a temperature of about 300° F., which may often be accomplished at small expense, the efficiency is greatly increased; in some cases this has been shown to be as high as 80 per cent. While the lower pressures are yet more efficient, the loss due to higher compression is not serious.

If air be used without expansion it will be seen that there is a material loss in efficiency; but, on the other hand, if it be used expansively without reheating, trouble may be experienced, due to the drop in temperature below the freezing point. If moisture be present this will cause the formation of ice, which may clog the passages if proper precautions are not taken to prevent it. The low temperature will not in itself cause trouble; if, therefore, the moisture which the compressed air holds in suspension be allowed to settle in a receiving tank, placed near the motor or other air apparatus and frequently drained, less trouble will be experienced from this cause.

While it may be impracticable to reheat the air in certain cases, yet there are many situations where a study of means to overcome the losses referred to would result in marked economies.

The greater adaptability of compressed air to various purposes causes its use to increase along with that of the electric motor, for it has a different field of usefulness, independent of power transmission; at the same time when the requirements are properly observed in its production and use, its economy as a motive power in special cases compares favorably with other systems. With a better knowledge of the principles involved we may expect much better results than have yet been attained.

But compressed air possesses so many advantages that, however inefficient it may be as a motive power, its application to shop processes will be continually extended as its usefulness becomes better known.

Mention has been made of the use of hydraulic motors as a factor in the subdivision of power, but these are being used to such a limited extent for this purpose that we shall not consider them at the present time.

There is, however, a growing field of usefulness for hydraulic power in manufacturing operations which is peculiar to this agent alone, namely, its use in forging and similar work. Where hydraulic power exists for this purpose it is also generally used for a variety of purposes which could be accomplished just as well, and often more

economically, by steam or compressed air; but in forging operations where heavy pressures are required hydraulic power is infinitely better than either.

The compressibility of air is an objection in many lines of work, and it is now well recognized that the effect of a hammer blow is oftentimes merely local. As Mr. H. F. J. Porter has so ably shown elsewhere,* the pressure applied in forging a body of iron or steel should be sufficient in amount and of such a character as to penetrate to the center and cause flowing throughout the mass; as this flowing of the metal requires a certain amount of time the pressure should be maintained for a corresponding period.

Hydraulic pressure, instead of a hammer, should, therefore, be used to work it into shape. Under its action the forging is slowly acted upon and the pressure is distributed evenly throughout the mass, whereas under the high velocity of impact of the hammer the metal does not have time to flow, and thus internal strains are set up in the mass, which may cause serious results, especially with certain steels which have not the property of welding.

Besides the fundamental defects incident to the method, it is very troublesome to use a hammer in certain lines of work, on account of mechanical difficulties of manipulation.

The quality of the steel is very much improved by the processes of hydraulic forging, and we find a marked tendency to substitute this method in a wide variety of work in which presses are employed varying in capacity from 20 tons to 14,000 tons.

We are all familiar with the fact that the magnificent 125-ton hammer made by the Bethlehem Steel Co. lies idle, while the work for which it was intended is done by a 14,000-ton hydraulic press operated by an engine of 15,000 horse-power; it may not be so generally known, however, that all forgings except small pieces are done on hydraulic presses, and that the largest hammer in actual operation is one of 6 tons capacity in the blacksmith shop.

* *Trans. A. S. M. E.*, Vol. XVII.

The pressure used in these works is 7,000 pounds per square inch, but the present tendency indicates the use of a so-called low-pressure transmission service under a pressure of 400 or 500 pounds, with an intensifier at the press which raises the pressure to 2,500, 5,000, 7,000 pounds, or whatever may be required.

In this case the lifting and lowering of the ram of the press is effected by low-pressure water, so that the cylinder always remains filled, and the high pressure is only brought to bear the moment the dies come in contact with the pieces to be forged. The intensifier is built in multiple, which permits of a variable force to suit the work to be done; its action and control are extremely simple, and results are produced which show a marked increase in speed and a decided economy in operation. Some of the recent German hydraulic forging machines equipped with intensifier operate at a speed of forty to seventy strokes per minute, on finishing, and twenty to thirty strokes per minute for the heaviest work.

The success which has attended the use of hydraulic power in forging is causing it to be applied to other and similar work to an increasing extent. In boiler works, railroad and locomotive shops, bridge works and ship-yards it is used along with compressed air, but where heavy pressures are desired hydraulic power is greatly to be preferred; hence we find it operating machines for punching and shearing heavy plates and sectional beams, riveting machines, stationary and portable, flanging and bending machines, tube upsetting ma-

chines, wheel and crank-pin presses, lifting jacks and hoists of all kinds.

For heavy boiler work hydraulic riveting seems especially well adapted, as an intensity of pressure can be brought to bear upon the plates which is obtained by no other method.

We have already stated that compressed air as now used without reheating is not at all efficient as a source of motive power, since the combined efficiency of compressor and motor, even under favorable conditions, is not more than 50 per cent. of the available energy put into the compressor. In other cases the efficiency is as low as 20 per cent.

In the transmission of air, within reasonable limits, the loss in transmission if the pipes be tight need not be considered, for although there is a slight loss in pressure due to the frictional resistances of the pipes, yet there is a corresponding increase in volume due to drop in pressure, so that the loss is practically inappreciable.

There should be no comparison between the cost of power by compressed air and its brilliant rival, electricity, since each has its own field of usefulness, yet it may be interesting to note for our present purposes the efficiency of electric power. A modern shop generator belted from an engine will have an efficiency of about 90 per cent. when working under favorable conditions, but as the average load is ordinarily not more than two thirds full load, and often much less, the efficiency will not usually be more than 85 per cent. Since the engine friction was added to the losses in compression, so also it should be considered here, in which case the efficiency of generation will lie between 75 and 80 per cent. With a three-wire 220-volt system, which is very suitable for ordinary shop transmission when both light and power are to be taken off the same dynamo, the loss in transmission need not be more than 5 per cent., so that the efficiency at the motor terminals will not be far from 75 per cent. With motors running under a nearly constant full load the efficiency of motor may be 90 per cent.; but with fluctuating loads this may fall to 60 per cent. at quarter load. In numerous tests made by the speaker the average load on several motors in machine shops has been only about one third of the rated capacity of the motor. It is interesting to note that in tests made at the Baldwin Locomotive Works it was found that with a total motor capacity aggregating 200 horse-power, a generator of only 75 kilowatts was sufficient to furnish the current, and ordinarily only 60 kilowatts, or 40 per cent., was required. At the present time there are in use at these works upwards of 300 motors, with a combined total capacity of 2,200 or 2,300 horsepower; whereas the generator output is only about 500 kilowatts.

Under those conditions, where the driven machines are not greatly over-motored, we may assume a motor efficiency of 80 per cent., which may be less or greater in individual cases. The combined efficiency, then, of generator and motor working intermittently with fluctuating loads will be about 60 per cent. of the power delivered to the engine.

For greater distances than those which obtain in plants of this character the loss in transmission will be greater, and higher voltage must be employed in order to keep down the line loss. While it is possible to put in conductors sufficiently large to carry the current with any assumed loss, yet the cost of the line becomes prohibitive with low voltage.

Where cheap fuel is available it is found in most cases that electric power can be generated at the works more cheaply than it can be purchased from a central station;

especially is this the case if the exhaust steam be used for heating purposes. In isolated plants the cost of transmission is very small as compared with the total cost of generation; whereas in the average central station the cost of transmission, which includes interest and depreciation on pole line, usually constitutes a large percentage of the operating cost.

In those localities where the cost of fuel is high, electric power can often be purchased more cheaply from a central station which obtains its power many miles distant and transmits it electrically to a convenient distributing center, where it is used for power and light.

The recent development in electrical transmission is very marked, and one constantly hears of some new achievement more wonderful than anything previously accomplished. Distances have been gradually increased until it is now possible to transmit electrical energy economically and in commercial quantities up to 150 and even 200 miles.

There has been a steadily increasing tendency to raise the line voltage in such transmissions, and to-day we find in successful operation voltages as high as 40,000 and even 60,000 as compared with the 4,000 and 6,000 volts of a few years ago.

As pointed out by Mr. A. D. Adams,* so far as present practice is concerned the limit of use of high voltages must be sought beyond the transformers and outside of generating and receiving stations. As now constructed, the line is that part of the system where a final limit to the use of higher voltages will first be reached.

In order to avoid the temporary arcing and leakage between the several wires it is necessary to place the wires a considerable distance apart, which, with higher voltages, may lead to a modification in construction of pole line. The plan of substituting a series of steel towers about 90 feet in height and 1,000 feet apart is being seriously contemplated.*

* *Eng. Mag.*, October, 1902.

In this case it is proposed to suspend the wires from tower to tower and separate them about nine feet apart. While expensive in first cost, it is thought that the satisfactory working of the system and freedom from breakdown, with the low maintenance and depreciation charges involved, would warrant the investment.

A more serious difficulty is found in the insulator, which is generally looked upon with distrust for the higher voltages in use to-day. With a more perfect insulator there would appear to be no good reason why the present maximum voltages should not be exceeded.

The possibility of electrical transmission thus permits of the utilization of available sources of power at great distances from the center of distribution; but while it is interesting to know that a certain amount of power may be transmitted a given distance with a high degree of efficiency, it is more important to know whether the same amount of power could be obtained at the objective point more economically by other means.

It has been suggested that the future of long-distance transmission depends largely upon the development of oil as a fuel; but at the present time the outlook for oil fuel in general competition with coal or long-distance transmission is not encouraging; while the development of the Texas and southern California oil fields has increased the visible supply and brought about increased activity in the use of liquid fuel, yet it is doubtful whether the advantages would be sufficient to cause it to come into general use as a fuel, since with a limited production and an increased demand for

* Geo. H. Lukes in *Trans. Assn. Edison Illuminating Companies*, July, 1902.

this and other purposes the cost would be correspondingly increased.

A number of railroads contiguous to the oil-producing centers have equipped their locomotives to burn this fuel, and it is used to some extent to fire marine boilers, and with great satisfaction; since its displacement for a given heating value is only about one half that of coal, and the labor cost is materially reduced.

It is also used quite extensively in certain sections of the country as a steam producer in power plants, but it is hardly probable that liquid fuel will be a serious competitor of coal, notwithstanding its many advantages. At the present time, as far as power for manufacturing plants is concerned, it is largely a question of transportation, whether oil can be laid down and handled at a given point more cheaply than coal. It is probable, however, that oil fuel will supply a local demand in certain sections where transportation charges, and possibly insurance, will permit its use at a low cost, and it is in this connection that it may become a competitor of electrical transmission.

One interesting phase of the power problem which forcibly presents itself to the engineer at the present time is the vast possibilities possessed by the modern combustion engine, which includes the various types of gas- and oil-engines. While its use as a motor in industrial establishments has been somewhat limited, yet there is a marked tendency to employ the gas-engine in manufacturing works, and a consideration of its advantages and cost of operation, together with its high thermal efficiency and possibility of still further improvement, indicates that, for a great many purposes, both steam-engines and electric motors may be ultimately replaced by gas-engines.

While the first cost of electric motors in the smaller sizes is considerably less than the cost of well-made gas-engines for similar capacities, the saving during the first six months of service, due to the more economical operation of the gas-engine, will often more than compensate for the difference in first cost.

That the gas-engine in both large and small sizes has reached a point in its development where it can fairly rival the steam-engine in reliability and satisfactory running qualities there can be no question. In point of fuel economy, a gas-engine of moderate size is on a parity with the largest triple-expansion steam-engines, and will give a horse-power on less than one pound of fuel.

The high price of gas in this country has contributed largely to those causes which have prevented a more common use of the gas-engine as a motor. For this reason the gas-engine has generally been used, not so much because of its high efficiency as a thermodynamic machine, but rather on account of its convenience and saving in labor. It is true that natural gas is cheap, but it is equally true that natural gas is not generally available.

It is to producer gas that we must look for any marked increase in the use of the gas-engine. Fortunately the manufacture of producer gas has reached a high state of development, and there are now in successful use several processes by which power gas can be made from cheap bituminous coals as well as anthracite and coke. The leanness of such gases renders them less effective per cubic foot of gas, as compared with the richer coal gas or even water gas; but this difference is more than compensated for by the low cost of production. It is upon such power gas that the commercial future of the gas-engine as a general motor depends.

A prominent factor in gas-engine practice which has attained a high degree of development in European practice is the

small gas producer. These generators are very simple in operation and furnish a convenient and economical means of obtaining power at a much lower rate than with the ordinary city lighting gas. Generally small anthracite coal or coke is used, but several methods employ bituminous coal, lignites or wood. With bituminous coal, means must be provided for removing the tar and ammonia and other products of distillation.

The process of generation in some of the more recent producers is entirely automatic and depends upon the demand of the engine, so that no storage capacity is required. The economy of these small producers is shown by tests which give one horse-power on a 16-horse-power engine with a consumption of only 1.1 pound of fuel. For engines above forty horse-power one horse-power can be obtained on seven eighths pound of fuel.

The gas-engine industry received a signal impetus when it was discovered that blast furnace gases could be readily utilized direct in combustion engines without the intervention of boilers and without any special purifying processes. A still more important circumstance which is far reaching in its results is the fact shown by Professor Hubert, of the Liége School of Mines, that the superior economy of the gas-engine enables equal power to be obtained with 20 per cent. less consumption of furnace gas than was formerly used in the generation of steam.

The successful employment of large combustion engines in this way utilizes vast sources of power which a few years ago were allowed to go to waste or at most were used very inefficiently.

The high thermal efficiency of the gas-engine has long been recognized and the possibility of further development is a promising factor in this field. The already accomplished efficiency of 38 per cent. reported by Professor Meyer, of Göttingen, greatly exceeds the maximum theoretical efficiency of the steam-engine and more than doubles its actual best obtainable working efficiency, but the end is not yet.

With higher compression even greater efficiencies may be expected. But with high compression there is danger of premature explosion, due to the generation of heat in compressing the gas in the presence of oxygen; for this reason Herr Diesel compresses the air separately. Under a pressure of 500 pounds or more, which is used in the Diesel motors, the air becomes very hot and readily ignites a charge of liquid fuel which is injected into the compression chamber. There is no explosion; combustion occurs while expansion goes on and the heat generated disappears in the form of work.

Efficiencies of 30 per cent. or more have been obtained with blast furnace gases which contain a very small percentage of hydrogen, and this with the high rates of compression which can be carried has led to the advocacy of non-hydrogenous mixtures in large engines. Certainly very high rates of compression may be had with a non-hydrogenous producer gas without fear of premature ignition, and it has the additional advantage of economical production.

The practice of making the cylinder in combustion engines act alternately, first as air compressor then as motor, has the advantage of greater simplicity, but it means immensely larger engines for the same power, since the number of effective impulses is thus cut in two.

The danger of pre-ignition and consequent severe shock on the engine also necessitates very heavy construction in the smaller engines in order to obtain a reasonable degree of safety in operation.

Moreover, the smoothness of action is greatly retarded with this form of engine, especially if the governing is controlled by the 'hit-and-miss' method, in which the regulation is effected by varying the frequency of the explosions, thus causing great variations in the driving torque.

Various expedients have been employed to overcome these defects, such as the use of multi-cylinders and different methods of control, but the size and cost of engine have been increased rather than decreased. Notwithstanding these well-recognized defects in the four-cycle type of engine, it constitutes by far the largest class in use to-day of what may be called successful gas-engines.

More recently very satisfactory results have been obtained in the construction of two-cycle engines. In some of these we find separate pumps employed to compress the charge of gas and air, which ignites and burns as it enters the cylinder. Higher compression is thus obtained without fear of pre-ignition, and this permits smaller clearance spaces with attendant advantages.

If the engine is single-acting, an impulse is obtained every revolution, which thus insures better speed regulation, as well as double the power for a given sized cylinder.

The highest thermal efficiency yet attained, namely 38 per cent., has been secured with a two-cycle type of engine which compresses the air and gas in separate pumps to a nominal pressure of eight or ten pounds; the air under this pressure being used to scavenge the cylinder toward the end of expansion. After the unconsumed products of combustion have been forced out by the fresh air, the cylinder walls having been cooled thereby, a charge of gas is admitted and compressed to a pressure of 150 to 175 pounds per square inch and then exploded, as in the usual method. This engine is double-acting and receives a charge each side of the piston; thus two impulses are received each revolution, in a manner precisely similar to that of a steam-engine.

Whether these engines will be as satisfactory for small motors remains to be seen. It is possible that the greater complication of details in the two-cycle types, as compared with the simpler four-cycle engine, will cause the latter to continue to give the greater satisfaction, at least for the smaller sizes.

At the last meeting of the British Association, Mr. H. A. Humphrey gave some interesting data concerning recent gas-engines, and the record is both remarkable and significant. The limiting size has rapidly grown during the past two years, as shown by the fact that one manufacturer is now constructing a gas-engine of 2,500 horse-power and is prepared to build up to 5,000 horse-power.

The development of the large gas-engine is closely connected with the evolution of the fuel gas processes, and it is noteworthy that the first gas-engines in England above 400 horse-power were operated with producer gas, while many of the large gas-engines in Europe have been built for use with blast furnace gas.

In August of this year (1902) two leading English manufacturers had delivered or had under construction over fifty gas-engines varying in size between 200 and 1,000 horse-power; but we have to look across the Channel for still greater achievements in this direction.

Neglecting all engines below 200 horse-power, we note that a classified list of gas-engines in use or under construction shows the remarkable total of 327 gas-engines capable of supplying 182,000 horse-power. This gives an average of about 560 horse-power per engine.

As compared with this we find from the last U. S. Census Report that, during the census year 1899, there were constructed in the United States 18,500 combustion engines having a total capacity of 165,000 horse-power, or only about 9 horse-power per engine.

Although this country has lagged somewhat behind Europe in adopting large gas-engines, there is evidence that this state of affairs will not exist very long, for a number of enterprising firms are already in the field prepared to build gas-engines up to any required size. One firm has already sold over 40,000 horse-power of large engines, most of them of 2,000 horse-power and several of 1,000 horse-power. Another firm has recently built two 4,000-horse-power gas compressors and also a number of 1,000-horse-power gas-engines.

The use to which these large engines are put is about equally divided between the operation of blowing engines for blast furnaces and the driving of dynamos for general power distribution; the tabulated list compiled by Mr. Humphrey for engines of more than 200 horse-power shows 99,000 horse-power for driving dynamos for light and power and 83,000 horse-power for other purposes.

While the gas-engine in the larger sizes is thus used extensively for the generation of electric light and power, a growing tendency is observed to use the gas-engines direct as motors.

A number of railroad and other machine shops have been equipped with moderate-sized gas-engines suitably located about the works, and in addition, thousands of horse-power are used in the smaller sizes for a wide variety of purposes, including village water-works, isolated lighting stations, and manufacturing plants of all kinds.

With the possibilities of high thermal efficiencies we may look with much hope upon the still higher development of cheap fuel gas processes that will bring the gas-engine into very general succession to the electric motor for many purposes, for it will doubtless be found that gas transmitted from a central gas-making plant at a manufacturing works into engines located at points of use will effect a material saving in the utilization of power over any existing methods.

It is not to be presumed that the gas-engine will displace either the electric motor or the steam-engine; each has its legitimate sphere of usefulness, and each will be more highly developed as the result of direct competition. Yet the economies already obtained indicate that the field of the gas-engine will be extended more and more into that of the steam-engine and the electric motor.

Many of the questions involved in this consideration are at the present time in a transitional stage. The reciprocating steam-engine has reached a high state of development, but it is not probable that it has attained its highest degree of perfection. While an economy less than $9\frac{1}{2}$ pounds of steam per horse-power-hour has been obtained, even better results may be anticipated; the use of high pressure superheated steam in compound, jacketed engines involves more perfect lubrication, and this may demand modification in existing valve types; however this may be, the outlook is promising for still higher efficiencies; whether this will mean cheaper power than can be obtained in other ways will depend upon many conditions.

In any case, and especially with intermittent or variable loads, it is not so much a question of maximum efficiency as it is economy of operation.

From this point of view the present activity in the construction and development of the steam-turbine is of interest to en-

gineers and power users. The steam consumption of a modern steam-turbine of moderate size compares very favorably with that of the better class of large reciprocating engines, but what is of greater importance is the evident superior steam economy under variable loads. The steam consumption per horse-power-hour varies little from one third to full load; at overloads the economy, as shown by numerous tests, may be even better.

This feature predestines the steam-turbine to the special field of electric lighting and power generation, where it must inevitably become a formidable rival of the larger-sized slow-speed reciprocating steam-engine.

It is a significant fact that immediately following upon the installation of the large 8,000-horse-power compound steam-engines at the central station of the Manhattan Elevated Railway, New York, we find three 5,000-horse-power steam-turbines under construction for the Rapid Transit Company, of New York.

The high rotative speed of the steam-turbine is a prominent factor in favor of its adoption in connection with electrical generators, since the cost of the generator end of the equipment ought eventually to be very materially reduced; but for many lines of work the high rotative speed of the present types of steam-turbine is prohibitive, nor can it be adapted successfully to belt driving, except by the use of gearing. However, it is fair to presume that the present limitations of the steam-turbine are not insuperable, and that the attention which is now being given to its development will evolve a more universal type of motor adapted to general power purposes with large and small units alike.

The economies already obtained with both the steam-turbine and the gas-engine have brought each into a prominence which is at least suggestive of the important developments that are taking place in methods of obtaining and using power.

JOHN JOSEPH FLATHER.

THE PERPLEXITIES OF A SYSTEMATIST.*

A FORMER Chairman of this Section gave utterance in his retiring address to the following frank expression of sentiment: 'So welcome to the old-fashioned systematist, though his day be short, and may he treat established genera gently!'

If this cheerful prognostication is to be realized, the perplexities of the systematist are of short duration at best, or worst, and it were better for us, in view of our impending doom, to come before you to-day with the historic 'Morituri te salutamus,' and then kindly but firmly retire to the oblivion so imminently before us.

But on second thought we find ourselves not at all in the mood to fulfil the expectations of the genial oracle referred to, and, indeed, very much alive and willing to continue in the struggle for existence, although an even worse fate than death is offered as an alternative when the same prophet predicts that 'the future systematic work will look less like a dictionary and more like a table of logarithms.' Of course there is no gainsaying the fact that those who prefer logarithms will have them, but I will also predict that the number who will choose the lesser evil of the dictionary will remain for an indefinite length of time very much in the majority, even if this choice dooms them to the outer darkness where the 'old-fashioned systematists' are to be relegated by the logarithm proposers.

However this may be, certain it is that there will always be need for the men who perform the hard and often thankless task

* Address of the chairman of the Section of Zoology and vice-president of the American Association for the Advancement of Science. Read at the Washington meeting, January 27, 1902.

of the systematist, and those of us who are still pushing forward in spite of the almost overwhelming perplexities of the work, to say nothing of the frankly expressed contempt of the men in whose service we toil, are by no means called upon to sing our 'Nunc dimitis.' It has occurred to me that it would be profitable for us to consider on this occasion the position in which we stand, make confession of our sins, which are many, state as clearly as possible the embarrassments which at times nearly overcome us, and attempt at least to point out some of the means by which we can better our position and our work.

As to our position before the general public, it must be confessed that the general public cares for us not at all. Of all departments of biological science, none offers so little that is attractive to the average man as that which has to do with classification and the host of outlandish names that the systematist delights, in popular opinion, to inflict upon the literature of his subject. The average college student agrees with the general public, and will be prone to elect anything rather than systematic zoology or botany. There is absolutely nothing that seems to him more hopelessly dull, forbidding and profitless than all matters pertaining to classification and nomenclature. But it is in the house of our friends that we are wounded most cruelly. Even the best of our fellow zoologists and botanists wish us nothing better than a speedy and painless, at any rate speedy, death, and the worst of them would be glad to hasten the day.

It is not my purpose to discuss at present the attitude of the general public, nor even that of the college student, important as it is to all of us, but some attention ought surely to be paid to the prevalent opinion of our colleagues.

Let us inquire then, briefly, into the reasons for the unfortunate attitude of these who ought to be our best friends. In my opinion the most fundamental cause for their discontent is to be found in their irritation in finding nothing fixed or definitely settled in our classifications, or even in specific or generic names.

It certainly does not conduce to the tranquility of mind of the morphologist who desires to discuss the variation of a certain structure in a given group of animals to find that his friend the systematist is utterly unable to delimit the group for him, or that no two authorities can agree as to the number of species, much less as to their names! Wishing to get upon some solid ground for his discussion, the morphologist asks in desperation: 'What is a species, anyhow?' And the systematist, if he is honest, is forced to admit that he doesn't know. Again, the morphologist, with a commendable desire to learn something of the classification in a general way, laboriously masters some scheme which seems to have met with general acceptance, only to find that the next authority that he consults scorns it utterly. Still again, wishing to discuss the geographical distribution or ecology of some limited group, he finds that no two systematists agree as to the number of species included or the names by which they should be called.

Now, all this is exasperating to the last degree, and we must deal gently with our friends who exclaim in desperation: 'Is there anything definitely settled in regard to any group of animals whatever?' or 'Have the systematists any real basis for their decisions, or are they anything better than the merest personal whims?' Can we wonder that they resort at times to absolute brutality, and propose logarithms?

Having thus admitted the unfortunate position in which we stand before our fellow zoologists, let us now turn our attention to the highly edifying endeavor to honestly confess our sins. I suppose that

every zoologist who does systematic work starts out with the idea that there is nothing else quite so desirable and altogether ecstatic as the discovery and naming of new species; and this feeling results, it must be confessed, in numerous synonyms and great confusion. That this is an almost inevitable phase in the career of the ambitious systematist must be frankly acknowledged, and must be endured with as much philosophy as possible, the prospect being cheered by the reflection that the phase is exceedingly evanescent, and is of inconsiderable duration as compared with the whole career of the systematist. I know that I shall be backed by every worker of experience when I assert that any systematist who has gotten beyond the callow period would very much prefer to be able to place a given form in a previously described species than to be forced to describe it as new.

Besides, those of us who are sufficiently unregenerate can take great comfort in the thought that no one more eagerly embraces the chance to describe a new species than the morphologist who thinks he has discovered a novelty, and he it is who most often dodges the necessity of careful research along bibliographical lines, and at the same time artlessly evades all proper responsibility for his crimes by the formula: 'If this interesting form proves to be new, I propose for it the following name.'

The naïve innocence of some of our embryo naturalists is sometimes quite refreshing. For instance, a year or so ago a young and enthusiastic student in a western state wrote me that he thought he had a new species of a group in which I am interested, and asked me to kindly send him the literature on that group. Not finding me able to see my way clear to accommodate him, he proceeded to describe the supposed new species, and gave it a name. The result proved that the name was preoccupied and that the species was only a somewhat common color variety of a well-known form.

We have all of us made ridiculous mistakes, however, and no systematist of any experience could afford to throw the first stone were the biblical condition enforced. We should be cautious, however, and not leave too many cracks in our harness to be discovered by our friends the enemy. There are certain things that we ought to stop doing, and stop at once. One of the worst sins of the systematist is inadequate description of species. The scientific world has a right to demand good clear descriptions, and is not slow to express its contempt for any remissness in this direction. As an example of this particular sin I would cite an instance given by an entomological friend, which I quote verbatim:

"The variety harrisii of *Cicindela sexguttata* is described thus: It differs from typical *sexguttata* in the color, which is olivaceous green, and *in living at a considerable elevation.*"* It is not often that the variety maker is so refreshingly frank as this.

Another illustration is furnished by one of our energetic and intrepid young ornithologists, who evidently believes that each geographical locality ought to yield a trinomial for each bird inhabitant. He says:

"The differences characterizing this new form are not such as may be graphically described, but they are, nevertheless, quite apparent on comparison of specimens."

It appears from the context that this subspecies is based on a single specimen, but, coming from a different region, like the 'living at a somewhat higher altitude' of the insect referred to above, seems to be in reality, if not professedly, a zoological character. It seems to your speaker

* The italics are mine.

that a difference that is so elusive that it cannot be graphically described is not a proper basis for even a new subspecies.

The question here arises: Is there any legitimate limit to the refinement of description and niceties of distinctions between species or subspecies? There are many that hold that any difference whatever is sufficient basis for a specific description so long as there is no intergradation with other forms. Now it is evident that differences may be so small that intergradations are practically, although not theoretically, impossible. The keen eye of the expert systematist becomes almost microscopic in its function and sees differences that appear perfectly evident to the observer, but that are really intangible to the general zoologist, to say nothing of the scientific public at large. Should each of these microscopic differences be dignified with a separate name? If so, can we wonder that the non-systematic brother becomes thoroughly disgusted with our discussions of the zoological 'filioque' and consigns us all to quick extinction or a lurid future of logarithms?

It is to be hoped that the future will disclose some method of preserving scientific exactness, and at the same time obliterating the excessive pedantry that at present seems to be the main objective with certain systematists. And there is good biological ground for this hope in the law enunciated by our lamented Cope as the 'law of the unspecialized.' This, he says, 'describes the fact that the highly developed or specialized types of one geologic period have not been the parents of the types of succeeding periods, but that the descent has been derived from the less specialized of preceding ages.' There is no doubt that the extremists have their time and their uses, but they are not likely to be followed in their extreme positions by their successors of coming generations. It may be confidently predicted that the future will disclose a safe mean between the lax methods of many of the older zoologists and the indefensible hair-splitting of the extremists among the so-called advanced systematists of to-day.

In the estimation of the general scientific public the most grievous of our sins is the making of synonyms, and there is no question that we have much to answer for in that direction. There are few, however, that are in a position to realize the difficulties, amounting almost to impossibilities, that confront even the most conscientious worker. He has in hand a form that he cannot place in any known species, although he would be saved a deal of trouble if he could. He must call this troublesome animal something. He cannot call it by an old name and so, perforce, he must find a new one for it. It belongs to an old and well-established genus to which hundreds of species have, in the course of more than a century, been referred. Every descriptive term that can possibly be made to apply to such an animal has long ago been used. Though the worker may live in some great library center, such as Boston or Washington, it is impossible for him to have access to all of the literature pertaining to even a limited group. Though he spend months in looking through dealers' lists and catalogues, he is bound to miss a number of papers any one of which may contain matter vital to his purpose. Having exhausted every available source of information, he at last ventures to decide on a name which seems to him to be apt, and not preoccupied. The more experienced he is as a systematist the less confidence he has that his name will stand, nor is he greatly surprised to be reminded by some loving friend that that name was used twenty years ago in a paper published in

Russian and issued by a local scientific society in Kamchatka.

To illustrate the hopelessness of consulting all of the literature on even the most limited subject I will venture on a bit of personal experience.

For the past ten years I have earnestly endeavored to consult all of the papers regarding a very small group of animals in which I am particularly interested. In addition to buying everything that was mentioned in numerous lists and catalogues from the best European book dealers, the libraries of Harvard, the National Museum, the Congressional Library, the private library of Dr. Agassiz at Newport, the library of the Naples Zoological Station and other famous libraries in Europe were faithfully consulted and a card catalogue of every reference to a species included in the group under consideration was made. After which it seemed that I could at last work with some confidence that nearly all of the possible synonyms were where I could get at them when wanted. A few weeks ago the mail brought me a paper published in Geneva, in which occurred no less than one hundred titles of papers relating to the group of animals in which I had been working, not one of which I had been able to find.

Now if it is so difficult, nay impossible, for one who has access to a number of the best libraries to feel confident of avoiding the creation of synonyms, how can we expect the young worker with access to only a few books to avoid the same catastrophe? Of course it is easy to say that he has no business to attempt systematic work, and perhaps we should be justified in such a remark. But, after all, our position would be sadly like that of the historic mother who forbade her daughter to go near the water until she had learned to swim.

There is a distinct danger in attempting to restrict systematic work to those exceptional persons who have access to first-class libraries. Thoroughly equipped systematists will be needed in the world for a long time to come, in spite of frankly expressed views to the contrary, and the ranks of those passing away must be filled by competent men. Such men must be supplied mostly from our colleges and universities, and it is futile to expect the few institutions having adequate libraries to turn out a sufficient number of men to do this work.

As a matter of fact, the very universities that are in the best position to do such work are the ones that offer the least encouragement to the would-be systematist. In my opinion, our best-equipped universities are falling far short of their proper function in not paying more serious attention to this part of biological science. Some time ago I received a letter from a zoologist holding a high position in one of our largest museums, in which he complained that, while they were able to find plenty of young men who could work out the histology of a definite organ, or the embryology of a species, or undertake experimental work, there was only one university that he knew of, and that a western one, that gave students the training that was necessary to make them competent to work up a collection. For years there have been waiting for suitable men the vast accumulations of material in our great museums, and it is impossible to find men able to work up some of the most important groups.

Such, then, is the situation. There is the most urgent need for competent systematists, and our universities, the natural source of supply, are doing next to nothing in the way of training men for this important work.

But the objection may here be raised that the systematist is a specialist of a kind that cannot be trained for his work in the ordinary university course.

Of course it is impracticable to turn out full-fledged systematists, but it is practicable to give men the kind of education that will enable them to take up systematic work to advantage after their college days have been completed. The mental or intellectual equipment needed by the systematist includes three prime requisites: (1) accurate observational power, (2) a well-trained and reliable power of discrimination, and (3) the power to describe accurately and in good English. Now, be it observed that these three accomplishments are the very ones that are the most valuable intellectual gifts in almost any walk in life, and hence it follows that that sort of education which turns out good timber for systematists is the very one that serves the best and most useful pedagogical purposes; and the plea which I here make for more attention being paid by our colleges to preparing men for systematic work, is at the same time a plea for the best and strongest preparation for almost any walk in life.

It will, of course, be conceded that the first of the requisites cited above, namely, accurate observational power, is the primary aim of work in all material science; and it will also be conceded that the education of the power of discrimination or judgment is also included in any thorough scientific work; but I do not believe that any other branch of biological science does so much toward evoking fine descriptive power as does systematic work, either in botany or in zoology. After an experience of some seventeen years as a teacher of science, it is my deliberate judgment that good descriptive ability is much more rare than the ability either to observe or to discriminate, which is really a part of observation. It would be laughable, were it not pathetic, to see the utter helplessness of even the better class of university students when they are told to describe even the simplest object. Time after time I have found that a class of twenty or more sophomores did not contain a single one who could really describe any definite object with even approximate success. But it is a never-failing delight to see the power that they can acquire in this direction after a year of faithful work along systematic lines.

Teaching of the sort that I have indicated need not be confined to the largest and best-endowed colleges. Fairly large collections in certain definite groups are a necessary prerequisite, but such collections can be secured at less expense than the laboratory equipment that includes a good compound microscope for each student, and in many cases the teacher can, with the help of students, make suitable collections in such groups as birds and insects.

The whole scheme of systematic arrangement lends itself admirably to the gradual evolution of descriptive power. Commencing with the larger groups, the student is drilled in discriminating the broader characters, such as differentiate classes and orders, for instance; then closer work is required in studying the families. Lastly, some few families are taken up and the work becomes focused on the fine discriminations required in describing genera and even species.

In the University of Iowa, for instance, the student works for one third of a year on the classes and orders of the lower invertebrates. Then he studies the groups of mammals, down to and including the families, for an equal length of time, the remainder of the collegiate year being devoted to the study of birds, more than half of this latter period being given to a careful study of the Passeres. The work is focused more particularly on birds because the university museum is particularly well equipped in birds, they are

pleasing objects of study for most students, and they are particularly available for illustration in such objects as coloration, geographical distribution and, strange as it may seem, ecological problems.

You will pardon me, I hope, for thus intruding the work of my own department upon your attention. But it serves to illustrate my meaning in claiming for systematic work the highest grade of pedagogical value. It does teach the student to observe carefully, discriminate with something of that judicial nicety so rare and so helpful in any life, and lastly—and it seems to me that this is the crowning achievement in education—to describe accurately not only from a scientific but also from a literary standpoint. Lucidity and accuracy of language accomplishes marvels in the way of inciting to lucidity and accuracy of thought, and, so it seems to me, actually precedes them in time.

All this may seem a digression from the main theses of my address, but it will be remembered that we are trying to find a remedy for the scarcity of men competent to occupy the field of systematic work, and the first thing needful is a realization on the part of our colleges and universities that they have too long neglected the educational value of training along systematic lines. Were they led to recognize this at its just value, it would be provided for on at least an equal footing with morphology in the curricula of all reputable colleges, and this would result in the graduation, yearly, of a number of young men and women who have the preliminary training that will enable them to take up systematic work in earnest.

Of course this real systematic work can only exceptionally be done in colleges. Not even as post-graduate work can it be attempted, save under circumstances seldom realized. But the men, if worthy, will find the place to work in centers where great museums and libraries will be at their command. In this connection the thought forces itself to the fore that the great and greatly discussed Carnegie Institution can do a most important work in seeing to it that such young men, equipped particularly for systematic work, can receive enough of a stipend to feed and clothe them while necessarily away from home and doing important systematic work in overhauling and bringing order out of the chaos that prevails in most if not all great museums, where a wealth of material has been allowed to accumulate for decades awaiting the time when the right man can come to the aid of overworked curators and intelligently and efficiently disentangle the all but hopeless masses of material, and, with keen insight and trained powers of description, successfully trace the obscure web of relationships and of descent. Thus the curators will be left free to do better and more worthy work along the lines of their chosen studies, relieved of at least a part of the all but intolerable burden under which they are staggering, and in spite of which so much excellent work has been done.

While no one more heartily condemns scientific provincialism than does your speaker, still we can rightly indulge the hope that the time will come, and that soon, when it will be unnecessary to send to Europe for men competent to report on collections made by our government expeditions, and when collections will be entrusted to American zoologists, *not* because they are American, but because they are best able to do the work in a satisfactory manner.

It is probable that nine out of ten systematists, if asked what, in their opinion, was the most thankless and wearying part of their work would unhesitatingly answer, 'The bibliographic work.' In nothing are our energies so wastefully and often need-

lessly expended. Now that the Congressional Library is at last in working order, it seems to me that it ought to be possible to undertake a work in this direction that would be not only an unspeakable boon to all who are engaged in systematic investigation, but also to the scientific public at large; for nothing that I can think of would go so far towards reducing the pernicious activity of the maker of synonyms to a minimum as a methodical and exhaustive publication of bibliographies in connection with which synonyms* would be promptly 'spotted' and reported at once to the scientific world.

Our Congressional Library is worthy of a nation's pride. Having had occasion to work there myself, I can say that nowhere can better service or more helpful courtesy be found than is accorded one who desires to do serious work within its walls. One must use it before he can form any just idea of the wonderful change that has been brought about since the present building was completed. Here is undoubtedly the best place in America to do bibliographic work, and here could be undertaken a public service that would be second to none in helpfulness to the naturalist, the systematic publication of bibliographies, perhaps following the general lines of the Concilium Bibliographicum, which has already rendered invaluable service, so far as current publications are concerned.

The Concilium Bibliographicum, however, can furnish but little help regarding publications of other than comparatively recent date, and this is the most pressing need of the systematist. This task, colossal as it is, could be accomplished if attacked systematically by a sufficiently large force of competent workers. It would not be necessary to complete the work in any group before the results could be available for general use. By a periodical mailing of cards some relief could very shortly be extended to all those who are known to be interested in any group, and as the history of our science covers less than a century and a half, a vigorous prosecution of the work would enable us to have authentic and reasonably complete bibliographies brought up to date within a very few years.

Such work need not, indeed should not, be confined to bibliographies of publications, but should include bibliographies of specific names. Every reference to a species should be given a separate card. These could be arranged both alphabetically and chronologically, and when such a bibliography is completed up to date a synonym can be detected with unerring accuracy. I speak from some little experience when I say that such an arrangement of cards is the greatest possible assistance and time-saver, as I have myself made a card bibliography of a single order of animals with which I am working. It includes some six thousand cards, and involves a card catalogue of authors, with their publications, of families, of genera and of species.

Of course such a plan as has been indicated could only be carried out by a corps of specialists, each having immediate charge of the work pertaining to some limited group, and the whole should be under the supervision of some public scientific organization such as the Smithsonian Institution, or possibly the Washington Academy of Science; such bodies being particularly available on account of their being situated in Washington, where most of the actual work would be done.

But what answer shall we give to our friends who plaintively implore us to 'deal gently with established genera'? It is in connection with this question that we are

* The word synonym is here used in its more general sense, including both autonyms and synonyms in a strict sense.

confronted with some of the most perplexing of our difficulties. How far are we justified in overturning that which is firmly established by usage in order to introduce schemes of classification that seem to us better and more rational?

Hoping that your patience has not been exhausted by the references already made to personal experiences, I beg your indulgence while I refer once more, for illustration, to my own work, which is a monographic treatment of an order of cœlenterates. In attempting to discuss the genera of a single family, the Sertularidæ, it was found that there were included in it about twelve apparently well-established genera. These had been carefully defined and the classification seemed a logical and good one. When, however, the great amount of sertularian material accumulated during the past twenty years by the *Albatross* and other government agencies, together with the results of recent work by our cousins across the water, came to be worked over, the fact became more and more apparent that not a single one of these established genera could hold, unless some entirely unnatural and arbitrary characters were used, such as would be employed in the construction of artificial keys. Not a single one of these genera, as defined, was exempt from almost ideal intergradation with one or more other genera. Here the investigator is confronted with a dilemma with several horns, if the bull be allowable, either one of which was fraught with most uncomfortable consequences. The following courses were open:

1. To adopt an entirely artificial system, for convenience only.

2. To throw all of the old genera into one, for the sake of scientific consistency.

3. To make a new grouping, involving a new lot of genera.

4. To use the old and well-established genera, pointing out the intergradations and frankly admitting their scientific insufficiency.

Considering these in order, we find that the first proposition, that is, to adopt an entirely artificial system for convenience only, would be eminently unscientific, a backward step that should not have serious consideration.

To throw all the old genera into one would be the course to which the strict dictates of the scientific conscience would impel the investigator. If one could set aside every consideration save the letter of the law, and be willing to be pilloried by his colleagues, this would be the proper course to pursue. As a matter of fact, however, such a course would involve the renaming of about nine tenths of the hundreds of species involved, and throwing all the knowledge so laboriously attained by our predecessors and contemporaries into pi, resulting in every worker in that group, or every one that wanted to mention a species, being forced to find out what the thing would be called under the new system, no matter how familiar he might be with the group. Should any one have the hardihood to precipitate such a disaster, he would not only be pilloried and execrated, but, I doubt not, would fail to secure a single follower, and all of his work would die with him and his name be anathema.

The third course, that is to make a new grouping under new generic names when necessary, and old ones when possible, would be an excellent solution were it not for the fact that months of the hardest study, with ample literature and material hitherto unsurpassed in abundance has resulted in the sad conclusion that no grouping can be devised that will not be open to the original difficulty, that of intergrading forms in all directions. Nothing would be gained, and much confusion

would result from this course, which, like the others, cannot wisely be adopted.

There remains then but one suggestion. That is to use the old and established genera, which will work in perhaps ninety-five per cent. of the cases, and frankly call attention to the intergradations so that no one will be misled.

In this way we can heed the pleading of our friends to 'deal gently with established genera,' and not bring disastrous confusion into the already overworked synonymy.

Of course this solution is far from ideal, and will doubtless meet with no little criticism, but it is an honest one, and it is hoped will meet with the gratitude of those who plead with us to 'deal gently with established genera.'

It is to be feared that we have been too lenient with those who have been heedless in the matter of overturning existing classifications before they are certain that they have something better to offer. The old proverb, 'Be sure you are off with the old love before you are on with the new' is one all too apt to be forgotten by the enthusiasts who are unable to distinguish the difference between becoming great and becoming notorious. A little wholesome conservatism is by no means to be despised. A system of classification is not necessarily better because it is new, and we need to redeem ourselves from the charge, all too well founded, that we are capricious in tinkering with matters that need the most careful pondering, and an application of Davy Crockett's motto, 'Be sure you're right, and then go ahead.'

Of course all real progress must be encouraged, and it will never do to allow considerations regarding public, or even scientific, opinion to deter us after we are sure we *are* right. Conservatism by no means means stagnation, but it does mean deliberation.

But I have already trespassed too long upon your time without even touching on several questions of vital importance, such as the 'A. O. U. Code,' the best medium of publication, an authoritative tribunal for the settlement of such questions of nomenclature as could rightly be submitted to such a body, and other matters that I had hoped to discuss.

In conclusion, let me urge the necessity of hearty cooperation and a good understanding between systematists and other workers in the field of biological research. None of us can afford a contemptuous attitude toward any other who is honestly striving to extend the limits of knowledge, even though his faults are many. In early days out West there hung in a popular dance hall the suggestive notice: 'Don't shoot the orchestra. He's doing the best he knows how'! The same plea in thought, if not in language, we would enter in behalf of the systematist.

C. C. Nutting.

SCIENTIFIC BOOKS.

Geschichte der Chemie und der auf chemischer Grundlage beruhenden Betriebe in Böhmen dis zur Mitte des 19 Jahrhunderts. Von Adalb. Wrany. Prag. 1902. 8vo. Pp. vii + 397.

Dr. Wrany's volume deals with the progress of chemical science and its allied industries in the kingdom of Bohemia from the earliest times to a comparatively recent period, in an exhaustive manner. The first section considers the development of alchemy, it being a part of the history of civilization; it records that the first Archbishop of Prague, Arnest von Pardubic, who became chancellor of the newly founded University of Prague, attended universities in Italy to study chemistry and alchemy; he died in 1364, being a century later than Roger Bacon, Albertus Magnus, and the noted physician Arnold de Villanova, but preceding Paracelsus by an equal number of years. The first Bohemian writer on alchemy was Johann von Tetzen, whose verses

on the philosopher's stone are dated 1412. The first person of high rank to practice alchemy was the Empress Barbara (wife of Emperor Sigismund, 1451) who acquired a high reputation.

The second section deals with the beginnings of pharmacy in Bohemia. Up to the end of the fifteenth century the art of the apothecary was chiefly connected with the merely mechanical preparation of drugs, but when iatro-medicine began to develop, chemical processes and medicaments acquired an important place in pharmacy; a certain Master Bandinus de Aretio (Aretino = Arezzo) is named as apothecary to Prague in a manuscript of the early part of the fourteenth century.

This second section contains an interesting and useful table giving the names by which a large number of pharmaceutical preparations were commonly known in the years 1585, 1699, 1750 and modern times (besides several intermediate years), which shows that Bohemia was little behind other nations in introducing chemistry and chemical nomenclature into pharmacy.

In the succeeding sections the author treats of the metallurgy and the technological industries of the sixteenth, seventeenth and eighteenth centuries (III.); of chemistry in educational institutions (IV.); of scientific researches and publications in the past one hundred and fifty years (V.), and progress made in all branches of chemistry up to the middle of the nineteenth century (VI.).

At the University of Prague the professor of botany gave the instruction in chemistry in accordance with the statute of 1654, and it was not until 1745 that a committee appointed to reorganize the curriculum reported in favor of establishing an independent chair, which was done the following year by the installation of Johannes Antonius Scrinci, the first professor of chemistry and physics in Bohemia. Scrinci at once gathered a quantity of apparatus, etc., at his own expense, and opened public lectures which attracted students from all parts of Bohemia as well as from adjoining nations. Among his successors should be named Josef von Freysmuth, who was the first professor of general and pharmaceutical chemistry in 1812; under him modern rooms and fittings were introduced, but he died at the early age of thirty-three. Among the Bohemians who became eminent in chemistry may be named Plischl, Lerch, Balling (1805–1868), noted for his treatise on fermentation and his work on sugar, and lastly Ammerling (1807–1884).

A comment of the author is true of other nations than Bohemia; he writes: 'Analyses made in the eighteenth century, as late as the second half, have only historical value.' This remark is made apropos of examinations of the many mineral springs, whose healing qualities early attracted attention.

In the last section of this comprehensive and carefully arranged work Dr. Wrany discusses the introduction and growth of the coal industry, of assaying, of iron smelting, of the extraction and refining of the precious metals (especially in Joachimsthal), as well as the metallurgy of lead, mercury and other heavy metals. Nor does he neglect the historical aspects of the industries peculiarly connected with chemistry, as the manufacture of ink, of matches, of dyestuffs, of glass, keramics, sugar and of the brewing of beer.

The volume is full of details not found elsewhere, and made accessible by an author and a subject index separately (why divided?).

Dr. Wrany is already known by his work on mineralogy in Bohemia, from a historical point of view (1896), but he has not survived the publication of the book under review. This book is clearly printed on good paper, but so wretchedly sewn (two stitches placed close together) that only with the greatest care in handling has it survived the examination made for this review, and it goes immediately to a bookbinder.

HENRY CARRINGTON BOLTON.

SOCIETIES AND ACADEMIES.

NEW YORK ACADEMY OF SCIENCES.

THE annual meeting of the New York Academy of Sciences was held at the American Museum of Natural History on Monday, December 15, at 8:15 P.M., President J. McKeen Cattell presiding.

The reports of the officers for the past year were presented, dealing with the work of the academy since the last annual meeting, on February 24. During this period, twenty-three meetings of the academy have been held, at which forty stated papers and four public lectures were presented. There are three hundred active members, of whom ninety-six are fellows. Among the important changes during the year mentioned was the decision to publish articles accepted by the publication committee as separate brochures, to be collected at the end of the year, and bound up with the proceedings. An entire formal reorganization, furthermore, has been effected. By the passage of a legislative act last winter granting increased powers to the academy, it has been possible to adopt a new constitution and new by-laws to suit the present needs of the academy. Many minor changes have therefore been made in details of organization, terminology and procedure. An event of considerable importance to the academy has been the change in place of holding meetings to the American Museum of Natural History.

No publications have been brought out, owing partly to lack of funds. As, however, the treasurer's report shows a much more prosperous condition of the academy, it is expected that publication will be resumed. The library, still in Schermerhorn Hall, Columbia University, has been carefully maintained, special efforts having been made to fill gaps in serial publications of value.

The following active members were recommended by the council for election as fellows, because of their scientific attainments or services, and their election followed:

Professor Edward F. Buchner, Clark University, Worcester, Mass.

Miss Esther F. Byrnes, Ph.D., Girls' High School, Brooklyn.

Dr. R. H. Cunningham, 200 West 56th Street.

Professor Albert W. Chester, 39 College Ave., New Brunswick, N. J.

William Dutcher, 525 Manhattan Ave.

Dr. Harrison G. Dyar, U. S. National Museum, Washington, D. C.

Dr. George I. Finlay, Columbia University.

John Eyerman, Easton, Pa.

Professor William J. Gies, College of Physicians and Surgeons, 537 W. 59th St.

Professor Amadeus W. Grabau, Columbia University.

Dr. John D. Irving, U. S. Geological Survey, Washington, D. C.

Dr. Gustav Langmann, 121 West 57th St.

Dr. H. R. Linville, DeWitt Clinton High School, 174 W. 102d St.

Professor J. E. Lough, School of Pedagogy, New York University.

Professor R. MacDougall, School of Pedagogy, New York University.

T. Cumerford Martin, The Monterey, West 114th St.

Dr. Adolf Meyer, Pathological Institute, New York City.

Dr. S. A. Mitchell, Columbia University.

Herschel C. Parker, Columbia University.

Dr. Frederick Peterson, 4 West 50th St.

J. C. Pfister, Columbia University.

Professor John D. Prince, 31 West 38th St.

Dr. H. G. Piffard, 256 West 57th St.

Professor Michael I. Pupin, Columbia University.

Dr. Ivan Sickels, 17 Lexington Ave.

Professor M. Allen Starr, 5 West 54th St.

George T. Stevens, M.D., 22 East 46th St.

C. A. Strong, Columbia University.

Dr. F. B. Sumner, 17 Lexington Ave.

Professor W. Gilman Thompson, 34 East 31st St.

C. C. Trowbridge, Columbia University.

Professor John F. Woodhull, Teachers College, West 120th St.

E. R. Von Nardroff, 360 Tompkins Ave., Brooklyn.

The annual election of officers was then held, and the following were chosen:

President, J. McKeen Cattell.

Vice-Presidents, Section of Geology and Mineralogy, James F. Kemp; Section of Biology, Bashford Dean; Section of Anthropology and Psychology, E. L. Thorndike; Section of Astronomy, Physics and Chemistry, C. L. Poor.

Corresponding Secretary, R. E. Dodge.

Recording Secretary, H. E. Crampton.

Treasurer, C. F. Cox.

Librarian, Livingston Farrand.

Editor, C. L. Poor.

Councilors: (three years) Franz Boas, Hermon C. Bumpus; (two years) D. W. Hering, N. L. Britton; (one year) E. B. Wilson, George F. Kunz.

Finance Committee, John H. Caswell, John H. Hinton, C. A. Post.

Vice-president Kemp was then called to the chair, and the president delivered his annual address, entitled 'The Academy of Sciences.' At its close a vote of thanks was carried, on the motion of Professor E. B. Wilson. The academy then adjourned.

HENRY E. CRAMPTON,
Recording Secretary.

DISCUSSION AND CORRESPONDENCE.

NOTES ON NEGRO ALBINISM.

LAST spring, while engaged in archeology work in Coahoma County, Mississippi, I noticed some negro albino children hoeing in a cotton field. The fact that there was more than one in the family led me to make inquiry which brought out the following facts. The grandfather of these children was an albino. He married a normal negro woman and had three normal sons. All three sons married. Two have had only normal children; but the third, who has been twice married, is the father of fifteen children, four of whom are albinos. The first wife had five normal children and one albino; the second, six normal ones and three albinos. I was unable to learn anything about the ancestry of these women.

The particular interest in the case is that the anomaly reappears in one of three lines of descent in the third generation. According to Mendel's law of heredity, we should not expect it to reappear at all. Yet, if we suppose that albinism was recessive in the mothers of these albino children, the observed result is just what we should expect.

These albinos, two of whom have attained full stature, and others in the vicinity, are noticeably taller and have broader shoulders than their normal fellows. Are these accompanying characters?

WILLIAM C. FARABEE.

NOTE ON MR. FARABEE'S OBSERVATIONS.

MR. FARABEE has kindly shown me the proof of his interesting 'Notes on Negro Albinism,' and generously consents to the publication of the following note with his own.

The point needs emphasizing that albinism in mammals in general is a *recessive character* in the sense of Mendel's law. Mr. Farabee writes as if this fact were generally recognized, but I doubt whether this is so. Last winter in my lectures on heredity, which were attended by Mr. Farabee, I showed from the statistics published by von Guaita in 1900 that albinism in mice is a recessive character. This result has been confirmed by Mr. G. M. Allen, who has been carrying on breeding experiments with mice, under my direction, for the past two years. Some results of Mr. Allen's work have been in manuscript for several months, but their publication has been unavoidably delayed. Meanwhile Bateson (1902), in two recent important papers on heredity, has made the first published recognition of the fact that albinism in mice is a recessive character.

During the last few months I have been able to demonstrate experimentally that albinism is a recessive character likewise in guinea-pigs and rabbits. Mr. Farabee's observations indicate that the same is true also in man. It is probable, therefore, that this is a general law of heredity in all mammals. But Bateson has shown that in certain crosses among poultry white plumage is a *dominant* character; consequently we must apparently limit our generalization for the present to mammals. Yet it should be pointed out that the white breeds of fowls used by Bateson in his experiments are not pure albinos, since the eyes, at least, of white birds are pigmented. Consequently we must exercise caution in generalizing from those experiments.

In the case of negro albinism observed by Mr. Farabee, the result is throughout a Mendelian one, on the hypothesis that albinism is recessive. For the original male albino married to a normal negro woman should have only normal offspring, in whom, however, *the albinic character is recessive.* The recorded observation is three sons, all normal.

Two of the sons, apparently, married wives who were 'pure dominants,' *i. e.*, who were entirely free from the recessive (albinic) character. The theoretical expectation in such cases is that half the offspring will be

pure dominants, and the other half dominants in whom the recessive character is latent; but both sorts will be alike (normal) in appearance, as actually observed.

The third son appears to have married each time a woman in whom the albinic character was recessive. The probability of such unions is indicated by Mr. Farabee's observations of *other albinos 'in the vicinity.'* For to every albino produced, where crossing with normal individuals takes place, there are certain to be produced *at least twice as many* 'normal' individuals containing the recessive character. If, as supposed, the third son and each of his wives contained the recessive character, we should expect one in four of their offspring to be an albino; the recorded observation is four in fifteen, a close approximation to the calculated result. W. E. Castle.

Zoological Laboratory, Harvard University, December 16, 1902.

MAGAZINE SCIENCE.

To the Editor of Science: The following letter from Mr. C. E. Borchgrevink, in regard to the criticisms published by me in Science of September 13 on the captions of the illustrations of his article on the eruptions of Mt. Pelée which appeared in *Leslie's Monthly* for July, has just been received. In justice to the author, I trust that you will publish this extract from his letter in your columns.

"From a correspondent I hear that you have made an attack on me based upon the article published in *Leslie's Monthly*. I am not responsible for those statements or for those errors in regard to photographs, which never met my eye before they appeared in *Leslie's Monthly*. Very few of those photographs came from my hand and I never of course claimed them." E. O. Hovey.

SHORTER ARTICLES.

AGGREGATE ATAVIC MUTATION OF THE TOMATO.

On former occasions I have described two remarkable cases of aggregate phylogenetic mutation of the tomato which occurred suddenly under my personal observation, in which publications* I used the term mutation in the special sense that has been adopted by Professor De Vries. The following remarks refer to reports that have reached me from correspondents concerning equally sudden and complete atavic reversion of similar plants and their fruit, for which process I here use the term mutation in its ordinary sense. While the main fact of atavic mutation is clearly stated in these personal reports, they are wanting in certain details necessary to a fuller study of the subject. They are, however, important as aids in an interesting line of inquiry.

In May, 1902, I received from Mr. H. J. Browne, of Washington, D. C., who was then in Havana, Cuba, on business, a package containing a cluster of small spherical tomatoes of the variety known as the Cherry tomato. An accompanying note informed me that they were obtained from the proprietor of a plantation a few miles from Havana who had grown them there, and who assured Mr. Browne that they were the immediate product of seed of the large and fine variety well known throughout our country as the Trophy. These Trophy seed were obtained from the United States and planted in Cuba. The resulting crop of fruit was excellent and perfectly true to that variety as regards size, color, consistence and edible quality; but the seed of those Cuban-grown Trophy tomatoes invariably produced there the small cherry variety. The planter further stated that essentially the same result occurred in the case of all the several other improved varieties of tomatoes, the seed of which he had also procured from the United States, and that the degeneration was in all cases complete, heritably permanent and of uniform character; and that the change equally affected the whole crop. Because of this constantly occurring and hereditary atavism the planter was obliged to procure fresh seed from the United States for every acceptable crop of tomatoes grown on his Cuban plantation.

Quite independently of the foregoing statement I lately received a similar one from Miss Mary E. Starr, of Morristown, N. J. Her observations were made upon her father's plantation on the Bayou Têche, St. Martin's

* Science, November 29, 1901. *Bull. Torrey Bot. Club.*, August, 1902.

Parish, Louisiana. The father there planted the seed of a choice variety of tomatoes which were obtained from the former family home in New York state, the first crop of fruit from which was perfectly true to seed. He was, however, then informed by a neighbor who had lived in that region many years that, to produce good fruit, seed must be obtained from the North for every year's planting, because all the seed of tomatoes grown in that southern region would produce the small, spherical, inferior fruit, from whatsoever improved variety the seed may have originally come. The neighbor's advice was taken, northern seed was annually procured for future crops, and the first crop of resulting fruit was in all cases as characteristic of its variety as if the plants had grown in their native northern soil. But the truth of the reputed atavic mutation was afterward repeatedly demonstrated on the Bayou Tèche plantation under Miss Starr's observation by growing and maturing plants from seed of fruit which was grown there from northern seed. The permanence of the atavic mutation was also demonstrated by hereditary constancy in successive generations; and its completeness was shown in every plant of the second southern crop from northern seed, as well as in all subsequent crops.

These two cases are stated so clearly by my correspondents, and agree with each other so closely as to the main facts, that one cannot doubt their genuineness. One also cannot doubt that many other similar cases are constantly occurring in various regions, the details of which are not publicly reported. This article is written in hope of eliciting such information of similar cases as shall materially aid further investigations. Reports of such cases should embrace detailed statements concerning attendant horticultural and local climatic and other conditions, and mention of the several varieties whose mutations are observed. The interest attending a consideration of the varieties involved in mutations may be illustrated by the cases of phylogenetic mutation before referred to. In those cases the mutative act was accompanied by the production of one specific form from another, and it is desirable to know if, in cases of atavic mutation like those just mentioned, the reversion may be direct from a specific form that has thus arisen. For example, in those phylogenetic cases the mutation was from *Lycopersicum esculentum* to *L. solanopsis*, and the discovery of a case of atavic mutation involving a retrograde change from the latter species to the former without retracing the varietal steps of the genetic line would, therefore, be of interest in connection with the theory that such mutations originate in molecular changes. In the case reported by Mr. Browne mutation was only varietal or intraspecific in its scope. That is, it was within the species *L. esculentum* because both the Trophy and Cherry varieties belong to that species, and I do not now know whether such atavic mutation as occurred in the cases here mentioned has ever been interspecific in scope, that is, from one species to another.

Cases of atavic reversion of fine varieties of tomatoes are well known to gardeners, but those are generally cases of varietal degeneration complicated by hybridization. In the cases reported by Mr. Browne and Miss Starr, respectively, mutation seems to have been sudden, complete and aggregate for the whole crop. It is, therefore, improbable that it was a result of hybridization in either case. If those northern seeds had been sown in their native soil one cannot doubt that their progeny would have been true to seed in successive generations. Therefore, one also can not doubt that the exciting cause of those atavic mutations was local for the regions in which they respectively occurred. In those cases of phylogenetic mutation which have been referred to, the initial step evidently occurred in the seed of the fruit of the Acme variety which I had myself grown from authentic Acme seed. So also in the cases of atavic mutation herein mentioned the initial step seems certainly to have occurred, not in the somatic cells of either root, stem, leaves or pericarp of the first crop of plants grown in southern soil from northern seed, but only in the germ cells of those plants. In subsequent generations, however, mutation extended to the pericarp, that is, to the fruit; but the

reports which I have received do not state whether any correlated change occurred in the foliage, stems or other feature of the plant's habit. It is, therefore, plain that one cannot satisfactorily discuss the nature of those cases of atavic mutation until more complete data are obtained. Still, one seems to be justified in assuming that the exciting cause of atavic mutation in those two cases is largely connected with climatic conditions, although the determinate cause of mutation, both phylogenetic and atavic, is apparently often independent of such conditions. It may be added that I have not yet been able to suggest an exciting cause for the cases of aggregate phylogenetic mutation which I have referred to; but the facts of that mutation are absolutely as I have stated them in the publications mentioned in the foregoing footnote.

Charles A. White.

Smithsonian Institution,
December 30, 1902.

CARNEGIE INSTITUTION OF WASHINGTON.

APPOINTMENT OF RESEARCH ASSISTANTS.

It is the purpose of the Carnegie Institution of Washington, among other plans, to encourage exceptional talent by appointing a certain number of research assistants.

These positions will not be those commonly known as fellowships or scholarships; nor is the object of this provision to contribute to the payment of mechanical helpers or of assistants in the work of the institution. It is rather to discover and develop, under competent scrutiny and under favorable conditions, such persons as have unusual ability. It is not intended to provide means by which a student may complete his courses of study, nor to give assistance in the preparation of dissertations for academic degrees. Work of a more advanced and special character is expected of all who receive appointment.

The annual emolument will vary according to circumstances. As a rule, it will not exceed $1,000 per annum. No limitations are prescribed as to age, sex, nationality, graduation or residence. Appointments will at first be made for one year, but may be continued.

It is desirable that a person thus appointed should work under the supervision of an investigator who is known to the authorities of the Carnegie Institution to be engaged in an important field of scientific research, and in a place where there is easy access to libraries and apparatus—but there may be exceptions to this.

Applications for appointments may be presented by the head of, or by a professor in, an institution of learning, or by the candidate. They should be accompanied by a statement of the qualifications of the candidate, of the research work he has done, and of that which he desires to follow, and of the time for which an allowance is desired. If he has already printed or written anything of interest, a copy of this should be enclosed with the application.

Communications upon this subject should be distinctly marked on the outside envelope, and on the inside, Research Assistant, and should be addressed to the Carnegie Institution of Washington, 1439 K Street, Washington, D. C.

MARINE BIOLOGICAL LABORATORY.

The Carnegie Institution of Washington has made a grant to the Marine Biological Laboratory and now has at its disposal twenty tables in the Laboratory at Woods Hole, Mass., for the season of 1903. These tables are intended for the use of persons engaged in original research in biology, and carry with them the right to be furnished with the ordinary supplies and material of the Laboratory. Applications for the use of one of these tables should be addressed to the Secretary of the Carnegie Institution, Washington, D. C., stating the period for which the use of the table is desired, and the general character of the work which the applicant proposes to do.

SCIENTIFIC NOTES AND NEWS.

The American Society of Naturalists at its Washington meeting during convocation week elected as president Professor William Trelease, of the Missouri Botanical Garden. Dr. Franz Boas, of New York, was elected vice-president and Professor Bashford Dean, treasurer. Dr. G. Ross Harrison was reelected secretary. Professor William T. Sedgwick,

of the Massachusetts Institute of Technology, and Professor J. McKeen Cattell, of Columbia University, were elected additional members of the executive committee. The time and place of the next meeting of the society were referred to the executive committee in consultation with the secretaries of the affiliated societies, but will doubtless be at St. Louis in conjunction with the meeting of the American Association for the Advancement of Science.

PROFESSOR J. H. LONG, of Northwestern University, was elected president of the American Chemical Society, in succession to President Ira Remsen, of the Johns Hopkins University.

AT the annual meeting of the American Mathematical Society the following officers were elected: *President*, Professor Thomas S. Fiske, Columbia University; *Vice-Presidents*, Professor W. F. Osgood, Harvard University, Professor Alexander Ziwet, University of Michigan, Professor D. E. Smith, Teachers College, Columbia University; *Secretary*, Professor F. N. Cole, Columbia University; *Treasurer*, W. S. Dennett. *Librarian*, Professor D. E. Smith; *Committee of Publication*, Professor F. N. Cole, Professor Alexander Ziwet, Professor D. E. Smith; *Members of the Council*, Professor James Harkness, Bryn Mawr College, Heinrich Maschke, University of Chicago, Irving Stringham and W. H. Tyler.

MR. WILLIAM LUTLEY SCLATER has been selected by the council of the Zoological Society of London to succeed his father, Mr. Philip Lutley Sclater, as secretary of the society. Mr. Sclater holds the position of director of the South African Museum at Cape Town.

MR. WILLIS L. MOORE, of the U. S. Weather Bureau, and M. C. A. Angot, of the Central Meteorological Bureau of France, have been elected members of the Royal Meteorological Society.

DR. J. WIESNER, of Vienna, has been elected a foreign member of the Linean Society of London and a corresponding member of the Academy of Sciences at Göttingen.

ON the occasion of his jubilee Lord Lister has been created, by the King of Denmark, a Knight of the Grand Cross of the Order of Dannebrog.

IN accordance with the recommendation of the Paris Academy of Sciences, M. Darboux has been appointed a member of the Bureau of Longitude in the room of the late M. Cornu.

DR. HERMANN NOTHNAGEL, professor of clinical medicine and therapeutics in the University of Vienna, has been nominated a life member of the upper house of the Austrian Parliament.

DR. FREDERICK W. TRUE, executive curator of the National Museum, has been placed in charge of the exhibits of the Smithsonian Institution and National Museum at the St. Louis Exposition.

DR. RUDOLF ADERHOLD has been made director of the Berlin Bureau of Health.

DR. CHARLES J. BELL, professor of chemistry in the University of Minnesota, died on January 4, aged forty-eight years.

THE scientific fraternity, the Sigma Xi Society, has established a chapter at Columbia University.

THE Colorado Institute of Electrical Engineers has been organized at Denver with the following officers: *Chairman*, Henry L. Doherty; *Vice-Chairman*, J. W. Stearns; *Second Vice-Chairman*, A. H. Weber; *Secretary*, Eugene Sayer; *Treasurer*, A. M. Ballou.

UNIVERSITY AND EDUCATIONAL NEWS.

IT is announced that among the New Year's benefactions of Dr. D. K. Pearsons, of Chicago, will be: Illinois College, Jacksonville, Ill., $50,000; Fargo College, Fargo, N. D., $50,000; West Virginia Conference Seminary, Buchanan, W. Va., $50,000; Fairmount College, Wichita, Kas., $25,000. This would make the total of Mr. Pearsons's contributions to colleges $4,000,000.

THE Board of Trustees of Hamline University in Minneapolis announces that an endowment of $250,000 for the university has been raised, principally in Minnesota. Messrs. James J. Hill and M. G. and J. L. Norton, of Winona, gave large sums.

IT is announced that the endowment fund for Schurtleff College, at Upper Alton, Ill., has been completed, and that $92,000 has been collected to pay the debt of Albion College, Mich.

THE trustees of Union College at Schenectady, N. Y., have received an offer from the General Electric Company to make a gift for the equipment of the electrical laboratory and the annual payment for salaries. The course will be in charge of Dr. C. P. Steinmetz, who will hold the position of professor of electrical engineering.

AT a recent meeting of the council of the North Wales University College, Bangor, it was announced that Lady Morgan intended to give to the college a sum of £2,500 to found scholarships in memory of the late Sir G. Osborne Morgan, a former vice-president of the college.

THE registration at New York University, which was omitted from the article on the subject by Dr. Rudolph Tombo, Jr., published in the issue of SCIENCE for December 26, is as follows:

College of Arts and Pure Science	257	
School of Applied Science	103	
Graduate School	181	
School of Pedagogy	355	
School of Commerce	125	
Summer School	113	
Law School	660	
Woman's Law Class	36	
University Medical College	298	
Veterinary College	55	2183
Deduct names repeated		113
		2070
Teaching Staff		210

THE following statements regarding the scientific work of Oxford University are included in a pamphlet issued by the vice-chancellor on the most pressing needs of the university: The keeper of the Ashmolean Museum estimates that not less than £3,500 will be required in the near future for additional cases and upper galleries to meet the rapid increase of the collections. Eventually it will be necessary to erect new exhibition rooms, basement rooms for storage, a coin room and lecture theater; also to add to the library and to provide a librarian. The need of space for extension is also felt by the committee of the picture galleries, and the keeper of the Hope collection of engravings. The want of lecture rooms for the use of the public teachers of the university is dwelt on in several of the replies. The desirability of instituting and maintaining a laboratory for experimental research in the field of psychology is urged by several professors. The urgent needs of the several departments of the University Museum would at the present time involve an additional capital expenditure of £33,000, and an annual expenditure of £3,050 (representing a capital of £100,000); the future needs specified show that a further capital sum of £60,000 and an annual outlay of £4,000 will eventually be necessary. An additional professorship (for which provision is already made by statutes not yet in operation) is asked for applied mechanics. Better endowment is asked for the professorship of human anatomy, the readership in pathology, the Slade professorship of fine art (which it is proposed to make resident and permanent), the Sibthorpian professorship of rural economy (now suspended), the chairs of geology, zoology, physics, and experimental philosophy, and the curatorship of the Pitt-Rivers Museum. A large extension of the system of readerships and lectureships is asked for in medicine, natural science, ancient history and archeology. The curators of the schools ask that the electric light may be installed there at a cost of £850.

AT a meeting of the senate of the University of London on December 13 it was decided to constitute an additional board of studies in human anatomy and morphology. Dr. Nathaniel H. Alcock was appointed demonstrator in the physiological laboratory till October 1, 1903.

SIR WILLIAM MUIR has resigned the position of principal of the University of Edinburgh. Among those suggested as his successor are Sir William Turner and Sir Archibald Geikie.

PROFESSOR JOSEF NUSBAUM has been appointed professor of comparative anatomy at the University of Lemberg.